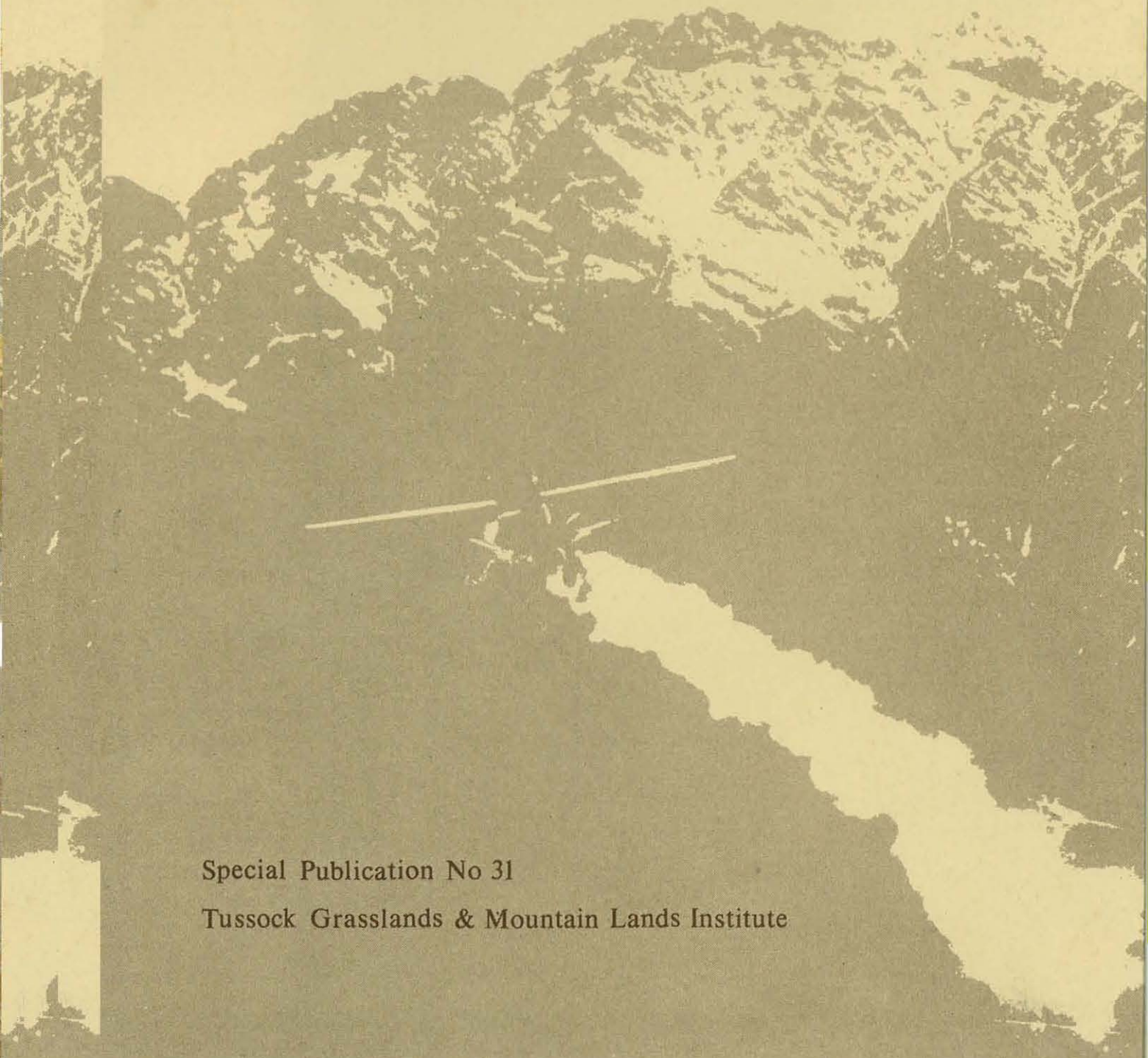
Phosphorus requirements and use for pastoral agriculture in New Zealand

M. Abrahamson • C. Darkey



Special Publication No 31

Tussock Grasslands & Mountain Lands Institute

PHOSPHORUS REQUIREMENTS AND USE FOR PASTORAL AGRICULTURE IN NEW ZEALAND

M. Abrahamson & C. Darkey

JUNE 1988

Special Publication No. 31
Tussock Grasslands and Mountain Lands Institute
Lincoln College

ISSN : 0110-1781

ISBN : 0-908584-41-5

Table of contents

Abstract

Pasture phosphorus requirements to replace on farm losses through animals and soil were calculated for a range of soil sets, and summarised for major soil groups, economic farm classes and provinces.

Predicted responses to P fertiliser on South Island "unimproved" soils were similar for 33 major soil groups out of 40[1]. Five further groups were almost similar in response. Olsen P data collected recently were similar to an earlier set (1977-79), and corresponded to relative pasture yields of top farmers within each group of soils. There were differences between the MWD estimates of stocking rates and census data of 578,000 stock units for the South Island and 100,000 for the North Island with however, more variability between provincial totals (average of 1,031,000 +- 600,000 for the North Island and 519,000 +- 400,000 for the South Island).

For the South Island, if Olsen P levels were below 10.2 for low producing pastures and 11.0 for high producing pastures, more P was needed for first year maintenance than for long-term at average farmer stocking rates. At top farmer stocking rates below an Olsen P of 12.4 more P was needed in the first year than for long-term on low producing pastures, while on soils with high producing pastures only one major soil group needed more P in the first year than for long-term. At potential farmer stocking rates all major soil groups with high producing pastures needed more P in the first year than for long-term maintenance, while all soils with high producing pastures with an Olsen P <19.5 needed more P in the first year.

Less P is needed for first year maintenance than for long-term at average and top farmer stocking rates for almost all the economic farm classes of the South Island. Unimproved soils of the North Island appear to be low in Olsen P and there are only two major soil groups where less P is needed for the first year than for long-term at average and top farmer stocking rates (recent soils and rendzina soils where Olsen P levels are above 14.0). Olsen P levels of improved soils in the North Island were not available. Olsen P levels of "unimproved" soils in the South Island were correlated with P retention levels, demonstrating an important relationship (effect) of P retention on their P status.

[1] Regardless of whether Olsen P values were derived from the MAF soil-testing service or from citric acid P and Truog P analyses.

North Island soils also have a greater range of P retentions than South Island soils and can account in part for the lower Olsen P levels of "unimproved" and higher pasture establishment P needs for North Island soils. Pasture establishment needs for North Island soils are double those needed for South Island soils.

Percentage relative yields of hill and high country in the South Island at average farmer stocking rates are lower than for other farm classes. Percentage relative yields in the North Island for all economic farm classes are uniformly high and do not show lower relative yields with less intensive uses.

Varying pasture utilisation or stocking rates allows a comparison of the importance of these factors in determining use of P per stock unit and opportunities for increasing efficiency. Application of P fertiliser to achieve potential farmer production levels would generally be an inefficient use of P fertilizer, in addition to providing a potential source for pollution of waterways.

The amount of fertiliser P actually applied during 1981 was within the range of predicted long-term requirements, between the requirements for soils on high producing pastures and the requirements for all soils, on low and high producing pastures. First year P needs for South Island soils were less than long-term needs.

First year P requirements for low producing pastures on North Island soils were similar to long-term requirements, reflecting the higher P requirements associated with higher soil losses in these soils. A greater percentage of the North than South Island has been topdressed and developed. About double the present use of P fertilisers would be needed if pastoral production was to reach the top farmer level. Only in South Island hill country has the amount of P applied per stock unit been sufficient to replace losses for the average farmer stocking rate. In the South Island high country and North Island MWBES farm classes for most of the years since 1969-70 the amount of P applied per stock unit has not been sufficient for the average farmer stocking rate. Fertiliser input in the last two years (1985-87) is about 50% of the needs for average farmer stocking rates on most MWBES farm classes and about 30% for North Island hard hill farms. These lower levels of fertiliser inputs will inevitably result in lower levels of pasture production if present pasture utilisation

remains the same. The dominant effect of soil P losses on P requirements per stock unit within provinces regardless of stocking rate suggests that it is more efficient to apply P fertiliser to soils where soil loss factors are low. Losses of P in animal products that are exported each year are about 20% of annual maintenance needs for 1981. This P in products needs to be replaced by P fertilisers or soils will become depleted. Some alternative form of agriculture may need to be considered when fertiliser stocks in the world have been exhausted. Also where pasture utilisations are very low (and relative yields, since both are derived from stocking rates) there are higher requirements of P per stock unit.

Pasture utilisation (and relative yields) for North Island low and high producing grasslands were similar, but there were lower levels on low producing than on high producing pastures for the South Island. Although efficiency of P use (kgP/s.u.) decreases rapidly at relative yields approaching the potential farmer stocking rates, on some soils, e.g. South Island high country yellow grey earths, efficiency of P use is better than for some North Island soils at average farmer stocking rates where soil P losses are high.

Acknowledgements

The main acknowledgement must be to Dr I. G. Cornforth and Dr A. G. Sinclair for their part in developing the model for the fertiliser recommendation scheme making this project possible.

This project owes much to the enthusiasm of Professor K. F. O'Connor, Centre for Resource Management.

Dr Allan Sinclair and John Morrison from Invermay Agricultural Research Station provided soil testing data and valuable comments on the final paper.

Ken Lefever, Centre for Resource Management, was able to translate our needs for data to MWD, Wellington and his help was essential for the successful conduct of the study.

Caroline Strachan, Stephen Walsh, Grant Hunter and Patrick Van der Berkel of MWD were very helpful in providing the data for the study. Their work also included a major revision of soil groups in the North Island.

Jackie Hemingway, Peter Ackroyd, Chris Kerr and Ken Leathers from the Centre for Resource Management assisted in the early stages in addition to a major effort by Joy Talbot.

The staff of the Centre for Computing and Biometrics (particularly Andy Griffiths and Margaret Quince) were helpful in sorting out SAS problems.

Dr Scott Black and Phil Tonkin, Soil Science Department, Lincoln College, had an input in grouping of soils into major groups.

Dr R. Parfitt, Soil Bureau, Wellington, commented on soil P tests and W. Saunders, Ruakura Agricultural Research Centre, provided correlations between soil tests.

Nicki Judson, Olga Cattanach and Pat Prendergast, from the Centre for Resource Management were responsible for typing and graphics and Brian Robertson for the final editing.

Finally thanks to Dr J. Hayward who was enthusiastic about the group study.

List of tables

List of figures

List of appendices

Introduction and calculation of phosphorus needs of N.Z. soils

1.1 Introduction

Phosphatic fertilisers are needed to replace phosphorus (P) losses from the soil due to soil immobilisation, leaching, animal transfer, and export of animal product or to maintain long-term pasture productivity. P is not replaced from the atmosphere, unlike some other nutrients (N, S.) and the only natural source on a site is from weathering of the parent material or the fresh deposition of soil by air or water. Under current farming systems, P removal generally exceeds the rate of natural replenishment so regular applications of phosphatic fertilisers are regarded as essential.

This study estimates the P requirements needed to replace the above losses from soils in New Zealand and also compares these requirements with current use of P fertilisers. This determination of P requirements and use is part of a group study at the Centre for Resource Management on phosphorus resources in NZ; the other completed part of the study was reported by Ward et al. (1985). The effect of the different factors used in calculating the P requirements is also discussed in this paper: for example some major soil groups in NZ have higher soil P losses than other soils, and need considerably greater inputs of fertiliser P to maintain agriculture. Low levels of pasture utilisation or of pasture production (relative yield) can indicate whether more fertiliser P should be applied or whether subdivision or some other management practice should be changed.

The current level of P fertility in the soil can be shown by a comparison of the first-year and long-term P maintenance requirements, both of which were calculated in this study, and by the soil Olsen P levels (which were needed for first-year P and for pasture establishment P estimations).

This study focusses on the agronomic requirements for P, assuming all suitable soils in N.Z. are used for pastoral farming. Studies have been undertaken by Scobie and St-Pierre (1987a, 1987b) and St-Pierre and Scobie (1987a, 1987b) into the optimum use of P when farm incomes are maximised.

1.2 Calculation of phosphorus requirements

1.2.1 Calculation of maintenance requirements for phosphorus

Phosphorus requirements were calculated in this study for all land suited for pastoral use, which includes land currently used for cropping and horticultural production. All land of capability classes I-VII, suitable

for agricultural use (Soil Conservation and Rivers Control Council 1971) has been included, but Class VIII land not suitable for agricultural use has been excluded. Pastoral farming with cattle or sheep of all soils in New Zealand was the only land use considered.

A model developed by Cornforth and Sinclair (1984) for the fertiliser recommendation scheme has been used for this study to estimate the phosphorus requirements for New Zealand soils. The mean annual pasture yield on a farm depends, to a large extent, on the annual P application rate, and it is limited by the maximum achievable pasture production which is specific to a site, (Cornforth and Sinclair, 1984). Stocking rates combined with animal feed requirements can be used to determine the maximum achievable pasture production and actual pasture production for sites. The National Water and Soil Organisation (NWASCO) of New Zealand maintained a comprehensive set of data on stocking rates typically carried by the average farmer, top farmer and attainable stock carrying capacities of many sites in New Zealand. These stocking rates were used for this study. The attainable potential carrying capacity (CC) is defined in the Cornforth-Sinclair model as "the number of stock units which would be carried on each hectare with an overall utilisation of 90% when pasture production is maintained at 95% of the maximum achievable with unlimited P application (Y max), and with annual DM (dry matter) intake of 550 kg per stock unit." The following equation can be derived from the above definition of attainable potential carrying capacity

$$CC = (Y\ max \times 0.90 \times 0.95)/550 \qquad (1.1)$$

From the above definition, an estimate of the pasture required at any stocking rate is

$$\text{pasture yield} = SR \times 550 \times 100/Pu \qquad (1.2)$$

where SR = the stocking rate in standard stock units; Pu = the pasture utilisation rate. This is the quantity of pasture eaten as a percentage of the quantity produced during the year.

The required pasture yield as a percentage of the maximum achievable yield, Y max is given as:

$$\text{Required pasture yield} = \text{pasture yield} \times 100/Y\ max \qquad (1.3)$$

as % of Y max

Substituting Y max and pasture yield in Equation 1.3 using equations (1.1) and (1.2) results in

Required pasture yield as % Y max

$$= (SR \times 100 \times 0.90 \times 0.95 \times 100)/(CC \times Pu)$$

$$= (SR \times 8550)/(CC \times Pu) \qquad (1.4)$$

If Pu is known then Equation (1.4) can be used with the NWASCO data on stocking rates to estimate pasture yield for a number of sites.

Pasture utilisation

Pasture utilisation is estimated in this study using NWASCO stocking rates in a model suggested by Sinclair and Cornforth (1984) and discussed by Darkey (1986)

$$Pu = (SR \times 8550)/cc \times (55 + 40 \times (SR/CC)) \qquad (1.5)$$

As the stocking rate is increased the pasture utilisation is also increased. From equations (1.4) and (1.5) it can be seen that relative yield and pasture utilisations are obtained from stocking rates.

Replacement of P in the soil for maintenance of pasture production requires the replacement of P losses in the soil, losses caused by animal transfer of P in excreta and losses of P caused by the export of animal products containing P. These loss factors are included in the full "Super choice" model equation (Cornforth and Sinclair, 1984), equation (1.6)

$$\text{Maintenance P (kg/ha)} = \log_{10}(100/[100 - (8550 \times SR)/CC \times Pu)]) \times CC \times (0.005 \times CC + 0.275) \times (Pu \times ALF \times 0.0301 + SLF \times 5.79) \qquad (1.6)$$

Soil P loss factors are given for major soil groups (Table 2, Cornforth and Sinclair, 1984) and animal P loss factors (Table 3, Cornforth and Sinclair, 1984) for sheep, beef cattle and deer. These factors are further discussed in sections 1.7 and 1.8.

The maintenance P calculated in equation 1.6 is the long-term maintenance requirement. Maintenance requirements of soil sets were first calculated

(kg P/ha) and then multiplied by areas (ha) for the amounts of P needed for each soil set. P requirements were then summarised for major soil groups of North and South Islands (section 1.8), Meat and Wool Board Economic Farm classes (section 1.9) and for provinces.

Phosphorus fertilisers applied may be more or less than the long-term maintenance calculated (equation 1.6). Levels of P in the soil determined by Olsen P analyses and relative yields determined by the levels of production are used (Figure 2a, 2b, 2c in Cornforth and Sinclair, 1984) to calculate a modifying factor. The long-term P needs are multiplied by this modifying factor to obtain the first-year P needs. Soils are tested again later to determine whether long-term P needs are to be applied or whether the amounts need to be modified.

A large number of Olsen P values were available for South Island soils (section 1.8). This allowed a comparison of first-year and long-term P needs for these soils. In chapter 4 the actual use of P is compared with the long-term and first-year needs. Another set of soil P analyses - Truog P and citric acid P was available for the South Island and these are compared where possible with the Olsen P analyses. There were only a limited number of Olsen P analyses for the North Island so that only long-term P needs were able to be calculated for high producing pasture soils.

Soils were separated into soils with low producing and high producing pastures based on the pasture types present (see section 1.5). Separation of soils into "improved" or "unimproved", based on their stage of development, was not possible in this study. Unimproved Olsen P values were used for low producing pastures and improved Olsen P values for high producing pastures. P requirements for establishment of clovers on unimproved soils were also calculated, using Olsen P values for unimproved and P retention values as inputs.

The long-term P requirements (kg P/ha) were then multiplied by a factor from 0 to about 2.5 to correct the long-term P requirements for the Olsen P level in the soil, determined by soil tests, (so that the first year application of P could be varied, depending on the level of P in the soil).

The values of the straight-line regressions (Fig. 2a, 2b, 2c, Cornforth and Sinclair 1984) for prediction of modifying factors were used to calculate equations at intervals of 5 units of relative yield up to 80%, and at intervals of 2.5 units from 80-95% relative yield. The Olsen P values for

yellow brown pumice soils were divided by 2 as recommended by Cornforth and Sinclair (1984) before the modifying factors were calculated.

Calculations for the modifying factor for Olsen P levels also require calculation of the relative yield (of pasture):

$$\text{Relative yield} = 8550 \times \frac{\text{stocking rate} \div \text{potential}}{\text{stocking rate} \div \text{pasture utilisation}} \qquad (1.7)$$

Maintenance requirements from the tables were for yields up to, but not exceeding 95% of the potential maximum. Relative yield defined by Cornforth and Sinclair (ibid) is the pasture yield as the percentage of the maximum possible yield when all nutrients, other than nitrogen, are adequately supplied.

1.2.2 Calculation of pasture establishment P requirements

Phosphorus requirements for pasture establishment were calculated from a series of curves (Fig. 6, Cornforth and Sinclair 1984) using P retention and Olsen P values for "unimproved" soils. The series of curves from Figure 6 were put in tabular form at intervals of 5 units of P retention and Olsen P at intervals of 2.5. The pasture establishment P is intended for the establishment of clover-based pastures on undeveloped and reverted pasture land and could not be calculated for improved or semi-improved situations, as Figure 6 cannot be applied to soils of higher organic P levels (A. Sinclair, pers. comm.).

The following changes were made in accordance with those outlined by Cornforth and Sinclair 1984.

> YBPu soils and podzols, North Island, soil groups 7, 8, 9, 10, 14, 16, 18, 23 (see Olsen P discussion) need 90 kg P/ha for pasture establishment. South Island podzolised soils D10, D11, D12, F1, F2, F3 (see Olsen P discussion) also need 90 kg P/ha. North Island organic soils and South Island K1, K2, K3, peat soils need 75 kg P/ha.

The time lapse before starting maintenance P applications, as per maintenance model, is as follows:

For carrying capacity >6 su/ha: 1 year

For carrying capacity 3-6 su/ha: 2 years
For carrying capacity <3 su/ha: 3 years

1.3 Areas of soils

Areas of each soil set for the South Island provinces were obtained from the MWD Ladeda database on computer tape and used in the computer model for calculation of kg P needs for each soil set area.

North Island soil set areas were also obtained on computer tape from MWD, in addition to areas of each Land Use Capability unit for the soil sets in regions, provinces, different slopes and major soil groups. In both North and South Islands the total areas of soil sets of grassland of land capability classes 1-7 were separated into low producing areas with no high producing pasture present and high producing pasture areas, which were the remainder of the pasture areas. Low producing areas were the total areas of any land resource inventory units where grassland as distinct from scrub, forestry (P, P2-P6) was the first vegetation listed in the description of the unit and where there was no high producing pasture (P1) present. High producing areas were all the other grassland areas with some P1 grassland present (P1 >40% of unit area) or where p1 was the dominant grassland (<40% of unit area). Crop land was also included with the pasture areas, as cropland is considered to fluctuate depending on a balance of use for pasture and crop land. If data for land resource inventory worksheets had been collected at a different date, then crop land may have become pasture or the reverse and separation of crop land or pasture was not possible.

1.4 Major soil groups

The major soil groups of soil sets in both N. and S. Island were identified. South Island soil sets were allocated to major soil groups by use of a list of soil sets and major soil groups published by MAF, Invermay.

North Island major soil groups were last updated in 1950 (New Zealand Soil Bureau, 1954) and many soil sets have since been shown to have different properties from when they were initially classified. A recent classification of North Island soils (Cornforth et al. 1984) regrouped North Island soils sets into over 100 major soil groups. These major soil

groups defined by Cornforth et al. (1984) have now been incorporated into the MWD Ladeda database. The general survey soil set numbers (ibid) now have been allocated by staff of MWD to major soil groups through use of map symbols and maps common to both sets of data (Cornforth et al. 1984 and MWD data base). These major groups of Cornforth et al. are discussed with Olsen P data and are further aggregated into 41 groups for use in this study and into a final 12 major soil groups for the summary output data. About 2% of the pasture area of the North Island was not included in this study as general survey numbers were not identified for these soils; for the purposes of this study this was not considered to be important considering the inaccuracy of other inputs in the calculations.

1.5 Stocking rates (stock units/ha)

Stocking rates were needed for calculation of pasture utilisation, relative yield and for use with animal loss factors. Average, top and potential sheep stocking rates have been published by MWD for each land use capability class (LUC) in each province of the South Island, and for each LUC in ten regions (not provinces) of the North Island. The three levels of carrying capacity were defined as follows (NWASCO 1981).

1) Present average carrying capacity - the number of stock units per hectare (su/ha) which the "average farmer" is typically carrying on a particular land use capability unit.

2) Carrying capacity of the Top farmer - the number of stock units per hectare which the farmer with the highest level of stocking rate, but with at least average stock performance is carrying on a particular land use capability unit.

(3) Attainable (potential) carrying capacity - the number of stock units per hectare capable of being carried on a particular land use capability unit, assessed within the limits of present technology and given favourable socio-economic conditions.

The definitions were designed for the typical sheep/beef farming system, not for dairying, cropping or other systems, but in this study all pasture land as well as cropland was allocated stock carrying capacities. The "base" carrying capacity and not seasonal extremes apply in the above definitions. Stock carrying capacities were estimated for land use

capability units by the Ministry of Agriculture and Fisheries, Advisory Division, for each region.

For the South Island the dominant land use capability unit for a soil set in a statistical area (Province) was used to obtain the stocking rates for that soil set. The Land Use Capability unit (LUC) was identified for the soil set and the average, top and potential stocking rates of that LUC were used for rates of the soil set. For the North Island, separate LUC areas within each soil set were obtained on computer tape and stocking rates weighted for areas were used in the calculations for each soil set. North Island stocking rates followed the stocking rate set of data more closely as the relative areas of each LUC were used in obtaining stocking rates for a soil set but in the South Island a single LUC was used for each soil set.

1.6 Animal P loss factor (ALF), kg P/su

The animal P loss factor was used to account for losses of P in animal products and animal transfer to unproductive sites. Phosphorus is transferrred more on steeper slopes than on flatter areas, as discussed in the first paper on phosphorus losses (Ward et al. 1985). Each land use capability unit in provinces of the South Island and regions of the North Island had the dominant slope recorded. Animal loss factors were assigned to slopes recorded in the South Island extended legend of the land resource inventory worksheets. Slopes of A, B, C were in the 0-15^{o} range, D, E, were 16-25^{o} and F, G, were > 25^{o} and were classified into three groups of flat, easy hill and steep hill with animal P losses (kgP/su) of 0.7, 0.9 and 1.1 respectively. Soil sets were allocated animal P loss factors by the values of slope obtained from the LUC's.

The animal P loss factor was used with the three stocking rates to calculate the animal transfer and animal product losses. At higher stocking rates animal losses increased in direct proportion to the stocking rate, as the ALF is multiplied by the stocking rate in the calculations. However, at these higher levels of utilisation less animal transfer losses should occur as there is less opportunity for formation of stock camps. Cornforth and Sinclair (1984) have allowed for this by using a reduced animal loss factor in more intensive grazing situations. However, in this study only the animal loss factors for less intensive grazing were used.

1.7 Soil Olsen P levels, P retentions and soil P loss factors

Olsen P analyses for the South Island were available from the soil analyses of the MAF soil testing service at Invermay. These analyses were for pasture classes 0-8, which included all the pasture species mixes of legumes and grasses, undeveloped and developed pastures excluding pure lucerne pastures (MAF, 1967). Olsen P analyses from pasture classes 0-8 and from soils which have had all levels of P fertiliser applied in the last two years were used for estimations of the Olsen P modifying factor for improved soils of the South Island. Analyses from pasture classes 0-8 and from soils where no P had been applied ever were used for the South Island unimproved areas. Summaries of Olsen P and P retentions are shown in Tables 1.1(a), 1.1(b) for the South Island major soil groups. The Olsen P and P retentions were available for some of the South Island soil sets, and where there were missing values for a soil set, the mean for the major soil group was used.

The Olsen P analyses for unimproved soils (MAF soil testing service data) have been compared with other sets of soil P data. Large numbers of citric acid P analyses and Truog P have been published and the response to fertilizer P predicted by these sets of analyses is compared with the response predicted by Olsen P analyses in Table 1.2 with a key to the major soil groups in Table 1.1 for the South Island soils.

Dixon and Metson (1955) have reported that "pastures usually respond to phosphate topdressing when the citric-acid-soluble P_2O_5 of the soil is 0.020 percent or less, but often when it is much higher", when discussing results of the North Island Survey, 1954. This limit of 0.020% P_2O_5 is the same as to the value of 8 mg% citric P chosen for the arbitrary cut-off level for a response to P fertilisers, Table 1.2. The 1% citric acid P test used for South Island soil analyses (Miller, 1968) was the same as that used for the North Island survey, except results were reported in P, mg% rather than P_2O_5 percent.

Cornforth (1980) has described how the categories of very low, low, medium, and high of Olsen P are defined, based on the probability of getting a response to added fertiliser. Soils in the "low" category will almost certainly respond to fertiliser while those in the "high" category almost certainly will not respond. There is more doubt about the chances of getting a response for soils in the "medium" category. Categories in Cornforth's definition also depend on the rainfall (Table 1.3) and

rainfalls were provided from New Zealand Soil Bureau (1968) for each soil set to fit major soil groups of the South Island into P status categories on the basis of their Olsen P values and rainfall. From Table 1.3 it appears that soils in the < 1000 mm rainfall range are outside the region of certain responses to P fertilisers, regardless of the level of Olsen P in the soil. The response to P fertiliser in the higher rainfall (> 1000 mm) is less predictable, depending on whether the response is in spring or autumn, but where Olsen P levels are below 20 then a response to P fertiliser would appear likely. The Olsen P values of the South Island major soil groups (from Invermay analyses on soils without applied fertilisers) are allocated to categories in Table 1.2, depending on the above criteria; P+ showing a certain response to P fertilisers and P- where a response is less likely, or uncertain. Similarly, in Table 1.2, P+ is shown for major soil groups below 8 mg% citric acid P where pastures usually respond to P fertilisers, and P- for groups above 8 mg% where responses are less certain.

In seven groups out of 40 a response to P is predicted for major soil groups based on citric acid P that is not predicted by Olsen P, and in all these groups the citric P mg% was not much below the arbitrary limit of citric P, 8 and in only two other soil groups was there a variance in prediction. This agreement in P response between the two sets of data for undeveloped soils for the South Island would give more confidence to the use of citric P analyses for this study in the North Island. It was suggested that Olsen P levels from Invermay were unexpectedly high for undeveloped soils (by contacts in Soil Science Department), but when the criteria of Cornforth (1980) for responses to Olsen P are considered there is close agreement between predicted P responses from Olsen P and those based on past sets of analyses.

There have been reservations expressed in the past about the use of citric acid P for assessment of P status in soils due to the measurement of organic P in addition to inorganic in the test, which does not occur to the same extent in Olsen P analyses, although the Olsen test also extracts P (org) as well as P (inorg) but it is not measured by MR reagent. Cox (1978) found the citric acid P test extracts rather large amounts of organic P, and higher values in gley soils and organic soils do not reflect the availability of P to plants, as organic P is mostly unavailable to the plants. However, the ability of the citric acid test to extract organic P is not universally accepted (R. Parfitt, pers. comm.).

Olsen P analyses were not available for the North Island from a soil testing service, as was possible for the South Island.

Citric acid P levels for all the major soil groups were available for the North Island from the Soil Survey (1954); up to 38 soil types in some of the 41 major soil groups had been analysed, mostly from untopdressed soils and this data is shown in table 1.4. Truog P soil analyses were also available, mostly from Soil Bureau Publications and Sherrell (1969), and these Truog P values were converted to Olsen P values through correlations established by Saunders (pers. comm., Table 1.5). These Truog P values were useful in estimating Olsen P values where citric acid P values were too high due to greater amounts of organic P as described previously.

In most soils apart from some BGEs and some recent alluvial soils, about 25% or more of total P extracted came from the organic fraction, (Saunders 1968), in addition to that from gley soils (Temuka 80%), the Yellow Brown Pumice (Taupo 79%), a central Yellow Brown Loam (Egmont 40%) and Northern Yellow Brown Loam (Kiripaka 80%). Blakemore (1960) has commented that organic P in Yellow Brown Pumice soils could produce higher P levels (citric acid P) than expected. Blakemore (1956) found that Yellow Brown Loams were probably low in P although citric acid P levels were medium due to higher organic P levels; some allophanic P is also dissolved by citric acid (R.L. Parfitt, A.S. Campbell, pers. comm.). Gley and organic soils in the North Island survey gave high values of citric acid P, but gley soils give good responses to P fertilisers (Gibbs 1980) and organic soils need heavy rates of P (Hupkens van der Elst, 1958), which would suggest these soils are low in P, despite medium to high levels of citric P.

The Truog P test overestimates actual P levels on recent soils from alluvium and gley soils (Metson and Cox 1978), due to the presence of Calcium bound P (in apatite) that is soluble in the Truog reagent, but not readily available to plants; for this reason Truog analyses for the recent soils are not used to predict Olsen P levels for the North Island. Considering the above limitations to both 1% citric acid and Truog tests and considering comments on P responses in articles in Soil News a composite picture of Olsen P levels for the North Island was established for undeveloped soils. The discussion and predicted Olsen P levels are given in Table 1.4.

Olsen P values for the 41 North Island major soil groups used in this study are also shown in Table 1.6, with Cornforth's major groups, summary soil groups of the study and P soil loss factors. Soil P loss factors (SLF) for major soil groups were taken directly from Cornforth and Sinclair (1984) for both the North and South Islands.

P retentions, needed for pasture establishment P calculations are shown in Table 1.7. Data for P retentions for the major soil groups had to be estimated in some groups, but for most soil groups published P retentions were available for the North Island.

Table 1.1(a)

Average Olsen P and P retentions of South Island soils from analyses on pasture classes 0-8 (including all pastures except lucerne).

Major soil Groups		Soil Moisture classes	Land forms		Key for Table	Olsen P * all levels of P applied in last 3 yrs no. in std.				Olsen P *: no P applied in last 3 yrs. no. in std.				Pretentions ** no. in std.			
						mean ($\bar{x}$)	sample (n)	dev. (S.D.)	summary	mean ($\bar{x}$)	sample (n)	dev. (S.D.)	summary	mean ($\bar{x}$)	sample (n)	dev. (S.D.)	summary
ZONAL LOWLAND SOILS	Brown Grey Earths	sub-xerous	Terraces + Fans	Intermediate	A1	16.1	20	8.1	A	13.5	4	5.0	A	9.6	37	3.9	A
				High	A2	13.0	6	5.0	$\bar{x}$ = 16.0	12.0	3	5.3	$\bar{x}$ = 14.4	12.9	18	-	$\bar{x}$ = 10.4
			Hills + Downs		A3	18.3	7	7.8		17.7	3	9.3		10.1	13	5.9	
			Steeplands		A4	-	-	-	S.D. = 7.5	-	-	-	S.D. = 6.0	2.5	2	-	S.D. = 5.4
	Yellow-Grey Earths	Dry sub-hygrous	Tces + Fans		B1	-	-	-		-	-	-					
			Hills + Downs		B2	17.7	36	6.8	B	18.9	13	5.4	B	16.0	62	6.5	B
			Steeplands		B3	-	-	-		-	-	-		14.1	22	5.1	$\bar{x}$ = 20.2
		sub-hygrous	Tces + Fans		B4	17.0	1075	9.4	$\bar{x}$ = 16.3	15.6	83	12.3	$\bar{x}$ = 14.6	20.9	114	8.4	
			Hills + Downs		B5	15.9	234	10.4		12.4	52	7.6		19.1	32	4.8	
			Steeplands		B6	22.8	21	20.5	S.D. = 9.4	17.4	5	8.5	S.D. = 11.2	19.0	6	3.6	S.D. = 7.8
		dry-hygrous	Tces + Fans		B7	17.5	743	10.0		17.2	75	16.5		23.5	43	5.3	
			Hills + Downs		B8	14.0	764	7.6		12.6	115	7.4		22.8	86	8.3	
			Steeplands		B9	16.0	47	6.6		16.0	6	3.4		22.5	2	-	
	YGE-YBE	Hygrous	Tces + Fans		C1	16.1	791	8.7	C, x = 16.3	13.8	30	9.0	C, x = 12.4	33.6	166	11.7	C, x = 28.3
			Hills + Downs		C2	16.4	1360	9.1		12.1	118	12.3		23.9	202	12.2	
			Steeplands		C3	-	-	-	S.D. = 8.9	-	-	-	S.D. = 11.7	-	-	-	S.D. = 12.9
	Yellow-Brown Earths	Weakly leached	Tces + Fans		D1	-	-	-		-	-	-		-	-	-	
			Hills + Downs		D2	-	-	-	D	-	-	-	D	-	-	-	D
			Steeplands		D3	16.7	6	9.2	$\bar{x}$ = 15.6	8.0	1	-	$\bar{x}$ = 16.4	20.0	4	-	$\bar{x}$ = 43.2
		moderately leached	Tces + Fans		D4	16.7	243	8.5		16.6	9	8.6		28.5	166	13.7	
			Hills + Downs		D5	14.7	227	5.9		-	-	-		41.0	96	15.8	
			Steeplands		D6	10.3	117	5.2	S.D. = 7.7	8.8	18	4.9	S.D. = 9.4	29.9	19	-	S.D. = 19.3
		Strongly leached	Tces + Fans		D7	17.2	491	8.4		21.0	71	9.4		50.0	389	16.4	
			Hills + Downs		D8	15.0	328	7.2		9.1	19	3.7		41.6	201	24.6	
			Steeplands		D9	-	-	-		-	-	-		-	-	-	
		Strongly leached + Podsolised	Tces + Fans		D10	15.5	190	6.3		11.6	9	4.8		52.8	57	9.2	
			Hills + Downs		D11	15.7	52	8.1		-	-	-		48.3	28	14.4	
			Steeplands		D12	-	-	-		-	-	-		-	-	-	
UPLAND and HIGH COUNTRY SOILS	Yellow-Brown Earths	Dry hygrous	Tces, Fans + Downs		E1	15.6	46	10.4	E	19.0	10	15.7	E	25.6	91	18.5	E
			Steeplands		E4	-	-	-		-	-	-		17.5	2	-	
		Hygrous	Hills		E2	12.7	6	1.5	$\bar{x}$ =16.7	12.3	3	2.1	$\bar{x}$ = 14.4	33.4	13	-	$\bar{x}$ = 34.6
			Hills + Downs		E3	17.1	254	10.0		14.3	41	5.8		39.7	159	17.5	
			Steeplands		E5	15.3	19	6.9	S.D. = 9.8	9.6	7	4.0	S.D. = 8.2	40.8	11	18.0	S.D. = 18.6
	Podsolised Yellow-Brown Earths	Hygrous-Hydrous	of little importance		F1	8.8	16	2.3	F, x = 17.1	8.9	8	2.1	F, x = 9.3	41.8	29	23.8	F, x = 38.7
			Southland		F2	18.8	97	9.3		8.0	3	1.0		55.2	70	13.8	
			rest of South Island		F3	13.5	11	3.4	S.D. = 9.0	16.0	1	-	S.D. = 2.8	13.9	50	14.2	S.D. = 24.5

* Olsen P analyses from MAF soil testing service, Invermay.
** Pretentions from Grigg (1980)
† Soil moisture classes described by Taylor and Pohlen, 1970.

Table 1.1(b)

Major Soil Groups	Soil Moisture Classes		Key for table	Olsen P, * all levels of P applied in last 3 yrs no. in std. mean ($\bar{x}$)	sample (n)	dev. (S.D.)	summary	Olsen P, * no P applied in last 3 yrs no. in std. mean ($\bar{x}$)	sample (n)	dev. (S.D.)	summary	Pretentions ** mean ($\bar{x}$)	sample (n)	dev. (S.D.)	summary
LOWLAND, UPLAND, and H.C. SOILS.	Hygrous, Hygrous-hydrous	BGL - YBE	G1	18.6	133	9.1	G	9.8	13	3.6	G	53.4	30	-	G
		BGL and Intergrades	G2	15.8	12	8.3	$\bar{x}$ = 18.5	10.3	3	6.8	$\bar{x}$ = 10.5	41.0	34	20.3	$\bar{x}$ = 51.8
			G3	10.8	4	5.6	S.D. = 9.3	8.0	2	7.1	S.D. = 4.6	65.1	29	18.3	S.D. = 18.3
		Mixed Parent Material	G4	19.0	82	9.8		12.6	7	5.0		49.4	30	17.2	
	Sub hygrous -hydrous	Rendzina, tussock developed under forest	H1	25.6	31	18.1	$\bar{x}$ = 28.6	14.4	11	8.0	$\bar{x}$ = 14.1	25.4	22	4.5	$\bar{x}$ = 29.4
			H2	44.3	6	33.1	S.D. = 3.6	11.0	1	-	S.D. = 7.7	32.3	30	13.0	S.D. = 10.8
RECENT ALLUVIA	Dry	Central Otago	I1	11.0	2	2.8	I	11.0	2	2.8	I	20.8	8	11.9	I
		Canterbury	I2	15.5	118	11.4		10.0	24	4.7		16.7	26	7.1	
		Marlborough	I3	-	-	-		-	-	-	$\bar{x}$ = 15.9	26.2	6	7.6	
		Nelson	I4	-	-	-		-	-	-		18.6	64	6.9	
	Dry to Fairly dry	Southland and Otago	I5	15.8	124	10.5		10.2	19	1.7	S.D. = 9.6	16.7	26	7.1	
		Canterbury	I6	17.4	147	7.9	$\bar{x}$ = 18.6	16.9	23	9.5		18.3	56	8.0	$\bar{x}$ = 31.1
	Moisture adequate	Nelson	I7	10.9	9	12.1		3.8	4	1.0		24.7	73	9.0	
		Southland	I8	19.9	365	9.6	S.D. = 10.2	14.2	18	4.1		32.0	103	15.6	S.D. = 9.7
		Otago	I9	18.1	75	9.6		23.0	16	14.5		18.1	25	9.4	
		Marlborough	I10	-	-	-		-	-	-		-	-	-	
		Nelson	I11	14.7	81	7.3		18.7	11	4.4		38.2	161	14.1	
		West Coast	I12	23.8	90	11.8		20.3	13	11.7		33.8	172	14.8	
	Irrigated	Non-saline C.Otago	J1	-	-	-	J	-	-	-	J	-	-	-	J
		Saline Central Otago	J2	-	-	-		-	-	-	$\bar{x}$ = 13.6	-	-	-	$\bar{x}$ = 26.3
		Lismore	J3	15.0	203	8.9	$\bar{x}$ = 14.9	12.7	3	3.8	S.D. = 4.6	26.3	20	4.6	S.D. = 4.6
		Others	J4	13.3	38	5.7	S.D. = 8.5	14.7	3	3.8					
PEATS	Peaty Loams		K1	10.5	26	6.4	K	10.0	7	8.4	K	74.0	1	-	K
	Medium acid		K2	18.2	46	5.1	$\bar{x}$ = 18.1	30.0	1	-	$\bar{x}$ = 29.6	51.3	9	12.9	$\bar{x}$ = 44.8
	Acid		K3	22.0	51	20.8	S.D. = 14.6	52.3	6	38.4	S.D. = 32.3	41.4	26	21.2	S.D. = 19.8
GLEYS	Southland and Otago		L1	18.7	327	9.5	L	17.7	26	7.1	L	33.3	87	14.8	L
	Canterbury and Marlborough		L2	24.0	400	16.6	$\bar{x}$ = 21.5	17.6	75	11.0	$\bar{x}$ = 17.1	20.5	45	7.4	$\bar{x}$ = 28.4
	Nelson and West Coast		L3	22.3	46	14.9	S.D. = 14.1	10.6	10	4.0	S.D. = 9.9	28.7	76	14.6	S.D. = 14.3
	Saline recent		L4	18.3	34	12.3		19.0	7	10.2		16.1	7	10.7	
YELLOW-BROWN SANDS	Under tussock - dry		M1	23.2	32	19.5	x = 23.5	21.2	21	20.1	x = 20.8	7.0	1	-	x = 24.3
	Under forest - damp		M2	24.7	10	11.9	S.D. = 17.9	12.0	1	-	S.D. = 19.7	25.0	23	15.3	S.D. = 15.1

* Olsen P analyses from MAF soil testing service, Invermay,.

** P retentions from Grigg (1980)

Soil moisture classes described by Taylor and Pohlen, 1970.

Table 1.2 South Island citric acid P levels for undeveloped soils (Soil Bureau Bulletin 27) compared with Olsen P values (Invermay) for "No.P" soils

Major soil groups (see enclosed key) and rainfall	1% Citric Acid P (mg %)	No. of soil types in soil group analysed (1 analysis per soil for citric P)	P category (citric P) and response to P fert. (see text)	Olsen P (Invermay) (*includes all P fert. levels)	P category (Olsen P + response see text)	No. of soil analyses for Olsen P
A1	23.6+11.0	5	V high -	13.5±5	med -	4
A2	17.0	1	High -	12.0±5	med -	3
A3	12±5	5	med -	17.7±9	med -	3
A4	21	1	high -			
B1	18±6	4	-	10.0±6	med -	6
B2	16±9	5	high -	18.9±5	med -	13
B3	8	2	med -			
B4	8.5±4	13	med -	15.6±12	med -	83
B5	6.3±4	17	med +	12.4±8	med -	13
B6	6.5±6	2	med +	17.4±9	med -	5
B7	12.4±9	12	med -	17.2±16	med -	75
B8	6.4±3.8	21	med +	12.6±7	med -	115
B9	12.0±4	3	med -	16.0±3	med -	6
C1	7.8±3	13	med -	13.8±9	high -	30
C2	6.0±4.7	23	med +	12.1±12	low +	118
D3	2.8±1.3	5	low +	8.0	V, low +	1
D4	11.6±4	7	med -	16.6±9	low +	9
D5	5.8±5	13	low +	14.7 ±6	low +	227
D6	4.8±3	6	low +	8.8±4	V low +	18
D7	7.4±4	7	med +	21.0±9	med -	71
D8	5.1±4	13	low +	9.1±4	V low +	19
D10	6	1	med +	11.6±5	low +	9
D11	7.6±2	3	med +	15.7±8	low +	52
E1	8.7±5	15	med -	19.0±16	med -	10
E2	12	1	med -	12.3±2	med -	3
E3	7.9±5	22	med -	14.3±6	low +	41
E4	8.0±5	3	med -			
E5	10.3±6	11	med -	9.6±4	V low +	7
F1	4.0±2	9	low +	8.9±2	V low +	8
F2	4.9±3	1	low +	8.0±1	V low +	3
F3	3.1±4	8	low +	16.0	low +	1
G1	1.0	1	V low +	9.8±4	V low +	13
G2	2	4	low +	10.3±7	low +	3
G3	24.0±24	2	V high -	8.0±7	med -	2
G4	15.4±16	5	high -	12.6±5	med -	7
H1	15.5±8	2	high -	14.4±10	med -	11
H1	7.7±7	8	med +	11.0	med -	1
I1-I12	19.4±9	23	med -	15.0	med -	136
L1-L4	12.3±6	20	med -	17.1	med -	118
M1	6.5±6	2	med +	21.2±20	high -	21
M2	7.5±5	2	med	12.0	low +	1

← Mostly below 1000mm rainfall

Mostly above 1000mm rainfall →

All rainfalls

1000mm

Table 1.3 Soil test nutrient ranges for predictions of response* to P fertilisers, from Cornforth (1982).

	Very low	Low	Medium	High
Olsen P				
Rainfall >1000mm				
Autumn	0-10	11-20	21-30	>30
Spring	-	-	0-20	>20
Rainfall <1000mm				
Autumn	-	-	0-20	>20
Spring	-	-	0-10	>10

* Very low and low, certain response to P.
Medium - some doubt about response.
High - unlikely to get a response to P.

Table 1.4

North Island Olsen P Values

Major soil group (see key for aggregation of Cornforths groups)	(a) Citric P (soil Survey, Soil Bur. Bull. 5)	No. of soils for Citric P	(b) Olsen P data Olsen P (or derived from Truog) and sources Sources	Olsen P	Rainfall (for category of Cornforth 1980)	Olsen P for major soil group
1. Re A Recent Alluvial	Med. .027±.011	4	(g) (b) (h) generally higher except where weathered)	7 (8)	Rainfall in North Island mostly above 1000 mm except areas in Hawkes Bay, Waiararapa 600-1000, West Coast >900 mm. (New Zealand Atlas)	20 (low) (Saunders, pers comm.)
2. Re Vo Recent Volcanic	Low-Med. .012±.005	9	(g) (b) (d) (h) more fertile than YBPu	12 (8) (13) (10)		10 low-med.
3. Ra Rendzina	Low-med. .012±.006	3	(e) (d) (h) only about ¼ of P as in S.I. Rendzinas. Hawkes Bay=2 x P in Auckland	(13) (20) (13) (20) (17)		Variable depending on part of N.I. 13-25 (19)
4. YGE Yellow-Grey Earths	low .008±.004 (YGE-mostly 600-1000mm)	3	(d) used Grigg's correlation (SI soils) as poor correlations Saunders (f) (c) (g)	(8.5) (9.0) (8.0) (8.5) (9.0) (8.5) (16),(13) (9.5) (9),(9) (13),(12) (9),(9) 8		low, 5 (Saunders, pers comm.)

Table 1.4 contd.

North Island Olsen P Values for undeveloped soils (cont.)

Major soil group (see key for aggregation of Cornforths groups)	(a) Citric P (soil Survey, Soil Bur. Bull. 5)	No. of soils for Citric P	(b) Olsen P data Olsen P (or derived from Truog) and sources Sources	Olsen P	Rainfall (for category of Cornforth 1980)	Olsen P for major soil group
5. YGE/YBE	Low .009±.004	8	(b) (f) (c)	(9) (8) (13) (6.5),(6.5),(7.5)	>1000 mm	low 8
6. YBPu/YBE	low .011	1				Low 11
7. YBPu	low-med. .017±.007	26	(d) (e) (f) (h)	(11),(11) 11.0, 11.5, 13.0 10.5, 10.0, 12.0 11 generally low in P although organic P could raise citric P levels, also low P in Sweet Vernal (Wells)	>1000 mm	Low 11
8. YBPu + YBL	low-med. .016±.008	14			>1000 mm	Low 11
9. P - YBPu/YBL	low-med. .017±.011	3			>1000 mm	Low 11
10. YBS (includes Podzols as same behaviour)	low-v.low .007±.006	12	(a) (b) (e) (g) (h)	(4),(12) (8) (7) 5,16 often responses to P - unweathered apatites present unavailable to plants	mostly >1000 mm	Low-v.low 8
11. N-YBS	v. low .002	2				v.low 5
12. G1-YBS						v. low 5

Table 1.4 contd.

North Island Olsen P Values for undeveloped soils (cont.)

Major soil group (see key for aggregation of Cornforths groups)	(a) Citric P (soil Survey, Soil Bur. Bull. 5)	No. of soils for Citric P	(b) Olsen P data, Olsen P (or derived from Truog) and sources Sources Olsen P	Rainfall (for category of Cornforth 1980)	Olsen P for major soil group
13. C-YBE's	Low .011±.006	17	(c) (16.5) (d) (9.0),(7.5),(9.0) (f) (16),(11) (h) YBE's generally low in P.	>1000 mm	low 11.5 (12)
14. C-P-YBE	v. low .002	1	(f) (8.5) (h) low in P	>1000 mm	low 11.0
15. N-YBE	v.low to low .005±.0025	38	(a) (8.0),(8.0),(9.0) (d) (9.0),(7.5),(9.0) (c) low in P	>1000 mm	v.low-low 8.0
16. N-P-YBE	.003	2	(d) (9.0) (h) very low in P	>1000 mm	5.0
17. YBL	medium .017±.011 see note in (h)	58	(a) (7.0),(5.0),(4.0) (b) (6.5),(6) (d) (11),(11),(11),(8),(7) (f) (9) (g) 12,10,3,11 (h) probably low P, as high P retention, med. citric P as high organic P		low 10.0
18. P-YBL	medium .014±.003 see note for YBL (h)	2			v.low-low 8.0
19. YBL/YBE	medium .013±.007 see note for YBL (h)	17	(f) (9),(9),(9),(9), 12.5 (h) YBL/YBE similar to CYBE's		low 10.0

Table 1.4 Contd.

North Island Olsen P Values for undeveloped soils (cont.)

Major soil group (see key for aggregation of Cornforths groups)	(a) Citric P (soil Survey, Soil Bur. Bull. 5)	No. of soils for Citric P	(b) Olsen P data Olsen P (or derived from Truog) and sources Sources Olsen P	Rainfall (for category of Cornforth 1980)	Olsen P for major soil group
20. YBL/BGrL	v. low .002	1			9.0
21. BGrL	v. low .004±.002	7	(a) (8.0),(11.0)(9.0),(8.0),(8.0) (8.0),(8.0) (d) (10),(10) (h) P soluble in NH_2SO_4 for loams about twice that for clays, but still not high	>1000 mm	low 9.0
22. N-BGrL	v. low .006±.005	7		>1000 mm	v.low 5.0
23. N-BGrL + P	v. low .002	1		>1000 mm	v. low 5.0
24. YBE/BGrL				>1000 mm	10
25. BGrLC	v.low .004±.002	12	(h) low in P	>1000 mm	7.0
26. BGrC			(d) (8),(8) (h) more weathered and low in P	>1000 mm	v. low 5.0
27. Br. + RL	low- v .low .005±.002	9	(a) (8.0),(8.0) (d) (8),(8),(8),(6)	>1000 mm	low 8.0
28. G1	organic P too high to use Citric P test		(h) Gley soils give good responses to P, but not need such high levels as could expect.	>1000 mm	low 8.0

Table 1.4 contd.

North Island Olsen P values for undeveloped soils (cont.)

Major soil group (see key for aggregation of Cornforths groups)	(a) Citric P (soil Survey, Soil Bur. Bull. 5)	No. of soils for Citric P	(b) Olsen P data Olsen P (or derived from Truog) and sources Sources Olsen P	Rainfall (for category of Cornforth 1980)	Olsen P for major soil group
29. G1-Re	see note for G1-high organic P			>1000 mm	low 8.0
30. G1-YBE	"			>1000 mm	low 8.0
31. N-G1	"		(h) low in P need about same P as SI soils		low 8.0
32. O	"		(d) (14) (e) (7) (f) (10) (h) need heavy rates of P as low in fertility	>1000 mm	low 10.0
33. Sa-G1-Re	(same as S.I.soil)?			>1000 mm	19.0
34. St	medium .018±.002	2	(b) steep land soils not leached as much, as runoff greater, so steepland generally higher P than flat.	>1000 mm	low 10
35. St-Ra	medium .018±.010	2	(h) Described as fertile	>1000 mm	same as Ra 13-25 (19)
36. St-YGE	.012	1		mostly less than 1000 mm	medium 12

Table 1.4 contd.

North Island Olsen P Values for undeveloped soils (cont.)

Major soil group (see key for aggregation of Cornforths groups)	(a) Citric P (soil Survey, Soil Bur. Bull. 5)	No. of soils for Citric P	(b) Olsen P data Olsen P (or derived from Truog) and sources Sources Olsen P	Rainfall (for category of Cornforth 1980)	Olsen P for major soil group
37. St-YBE (includes North and Central)	.012±.008	19	(b) (8.5),(7),(9),(11.5) (f) 8.5 (h) "mostly fertile" and some lower fertility; varies low to high	> 1000 mm	low-med. 12
38. St-Vo, St-YBPu, St-YBL, St-RBL	.014±.006	6	(e) (15.0),(9.0),(11.0)	> 1000 mm	range v. low to low-med. av. 10
39. St-BGr C+L	.003	2	(d) (8) (h) described as similar to BGr LC and farmed with them as one soil type	> 1000 mm	low 7.0
40. St-Re				> 1000 mm	16
41. St-YGE/YBE	.011±.006	11	(b) (7.5),(7.5),(11.5),(6.5) (f) 7.0	> 1000 mm	7.5 (18)

a* Bruce (1978)

b Campbell (1977)

c Cowie (1978)

d N.Z. Soil Bureau (1968)

e Pullar et al. (1978)

f Rijkse (1977)

g Sherrell (1970)

Table 1.5 Saunders' correlation of Olsen P tests (volume) with Truog P (volume) for North Island Soils, (and two S.I. soils for comparison).

Soil Group	Soil Type	Regressions	no. of samples n	r(corr. coeff.)
Yellow Brown Loam	Waihou	Olsen=4.30+1.22 Truog	30	.799
Northern Yellow Brown Sand, Yellow Brown Sand	Red Hill	Olsen=3.28+1.38Truog	23	.839
Yellow Brown Loam	Katikati	Olsen=6.92+1.52 Truog	32	.717
Yellow Brown Pumice	Taupo	Olsen=10.23+1.52 Truog	53	.675
Yellow Brown Pumice	Oruamui	Olsen=9.59+1.65 Truog	31	.858
Yellow Grey Earths	Matapiro	Olsen=5.03+1.65 Truog	32	.717
Yellow Grey Earths (S.I.)	Opuha	Olsen=7.89+.844 Truog	24	.588
Yellow Brown Earths (S.I.)	Hurunui (from Blenheim)	Olsen=12.62+.68 Truog	23	.359

Table 1.6 Soil Groups of North Island: Key to soil groups

(Cornforth et al. 1984) Major Soil Groups*	Major Soil Groups used in study for Olsen P + P retention values + SLF	Summary soil groups	Olsen P (see table11 of undev. soils)	Soil Los factor
Recent, Recent Alluvial	1 (Re-A)	1	10	0.10
Recent-Yellow Brown Loam	2 (Re-V)	1	10	0.25
Recent + Yellow Brown Pumice	2 (Re-V)	1	10	0.25
Recent Volcanic	2 (Re-V)	1	10	0.25
Recent/Yellow Brown Pumice	2 (Re-V)	1	10	0.25
Recent/Yellow Brown Pumice/Yellow Brown Loam	2 (Re-V)	1	10	0.25
Rendzina	3 (Ra)	2	19	0.25
Northern-Rendzina	3 (Ra)	2	19	0.25
Yellow Grey Earths	4 (YGE)	3	5	0.10
Yellow Grey Earths/Yellow Brown Earths	5 (YGE/YBE)	3	8	0.25
Yellow Brown Pumice/Yellow Grey Earth	6 (YBPu + YGE)	3	11	0.25
Yellow Brown Pumice+ Yellow Grey Earth	6 (YBPu + YGE)	3	11	0.25
Yellow Brown Pumice	7 (YBPu)	4	11	0.25
Podzolised-Yellow Brown Pumice	7 (YBPu)	4	11	0.25
Yellow Brown Pumice + Yellow Brown Loam	8 (YBPu + YBL)	4	11	0.40
Yellow Brown Pumice/Yellow Brown Loam	8 (YBPu + YBL)	4	11	0.40
Podzolised-Yellow Brown Pumice + Yellow Brown Loam	9 (P-YBPu/YBL)	4	11	0.40
Podzolised-Yellow Brown Pumice/Yellow Brown Loam	9 (P-YBPu/YBL)	4	11	0.40
Podzolised-Yellow Brown Loam	9 (P-YBPu/YBL)	4	11	0.40
Yellow Brown Sands	10 (YBS)	5	8	0.40
Yellow Brown Pumice/Yellow Brown Sands	10 (YBS)	5	8	0.40
Yellow Brown Pumice + Yellow Brown Sands	10 (YBS)	5	8	0.40
Recent + Yellow Brown Sands	10 (YBS)	5	8	0.40
Podzols	10 (YBS)	5	8	0.40
Northern-Yellow Brown Sands	11 (N-YBS)	5	5	0.40
Podzolised-Yellow Brown Sands	11 (N-YBS)	5	5	0.40
Gley-Yellow Brown Sands	12 (GL-YBS)	5	5	0.25
Yellow Brown Earth**	13 (C-YBE)	6	12	0.25
Yellow Brown Sands/Yellow Brown Earth	13 (C-YBE)	6	12	0.25
Northern-Yellow Brown Sands/Yellow Brown Earth	13 (C-YBE)	6	12	0.25
Yellow Brown Earth-Rendzina	13 (C-YBE)	6	12	0.25
Podzolised-Yellow Brown Earth	14 (C-P-YBE)	6	11	0.40
Northern-Yellow Brown Earth	15 (N-YBE)	6	8	0.25
Yellow Brown Earth/Brown Granular Clay	15 (N-YBE)	6	8	0.25
Yellow Brown Earth**	15	6	8	0.25
Northern-Podzolised-Yellow Brown Earths	16 (N-P-YBE)	6	5	0.40
Yellow Brown Loam	17 (YBL)	7	10	0.40
Podzolised-Yellow Brown Loam	18 (P-YBL)	7	8	0.40
Yellow Brown Loam/Yellow Brown Earth	19 (YBL/YBE)	7	10	0.40
Yellow Brown Loam + Yellow Brown Earth	19 (YBL/YBE)	7	10	0.40
Yellow Brown Earth/Yellow Brown Loam	19 (YBL/YBE)	7	10	0.40
Yellow Brown Loam/Brown Granular Loam	20 (YBL/BGrL)	7	9	0.40
Brown Granular Loam + Yellow Brown Loam	20 (YBL/BGrL)	7	9	0.40
Brown Granular Loam + Yellow Brown Loam + Gley	20 (YBL/BGrL)	7	9	0.40
Brown Granular Loam + Yellow Brown Loam + Yellow Brown Earth	20 (YBL/BGrL)	7	9	0.40
Brown Granular Loam	21 (BGrL)	8	9	0.40
Northern-Brown Granular Loam	22 (N-BGrL)	8	5	0.40
Northern Brown Granular Loam + Podzol	23 (N-BGrL + P)	8	5	0.40
Northern Brown Granular Loam	23 (N-BGrL + P)	8	5	0.40
Podzolised-Brown Granular Loam Clay	23 (N-BGrL + P)	8	5	0.40
Yellow Brown Earth/Brown Granular Loam	24 (YBE/BGrL)	8	10	0.40

Table 1.6 continued

(Cornforth et al. 1984) Major Soil Groups*	Major Soil Groups used in study for Olsen P + P retention values + SLF	Summary soil groups	Olsen P (see table 11 of undev. soils)	Soil Loss factor
Brown Granular Loam Clay	25 (BGrLC)	9	7	0.40
Central-Brown Granular Loam Clay	26 (BGrC)	9	5	0.40
Northern-Brown Granular Loam Clay	26 "	9	5	0.40
Yellow Brown Earth/Brown Granular Clay	26 "	9	5	0.40
Podzolised-Brown Granular Clay	26 "	9	5	0.40
Brown Loam	27 (BL,RL)	10	8	0.40
Red Brown Loam	27 (BL,RL)	10	8	0.40
Northern-Red Brown Loam	27 (BL,RL)	10	8	0.40
Red Loam	27 (BL,RL)	10	8	0.40
Gley	28 (Gl)	11	8	0.25
Gley-Recent Volcanic	29 (Gl+intergr.)	11	8	0.25
Gley Recent	29 "	11	8	0.25
Gley-Recent Alluvial	29 "	11	8	0.25
Gley + Gley Recent	29 "	11	8	0.25
Gley/Yellow Brown Earth	30 "	11	8	0.25
Gley + Yellow Brown Earth	30 "	11	8	0.25
Gley-Yellow Brown Pumice	30 "	11	8	0.25
Northern-Gley	31 (N-Gl)	11	8	0.25
Northern-Gley-Yellow Brown Earth	31 (N-Gl)	11	8	0.25
Organic	32 (O)	11	10	0.40
Organic/Recent	32 (O)	11	10	0.40
Saline-Gley-Recent	33 (Sa-Gl-Re)	11	19	0.25
Saline	33 "	11	19	0.25
Saline-Gley	33 "	11	19	0.25
Gley-Saline-Recent	33 "	11	19	0.25
Steepland	34 (St)	12	10	0.25
Steepland-Rendzina	35 (St-Ra)	12	19	0.25
Steepland-Yellow Grey Earth	36 (St- YGE)	12	12	0.25
Steepland-Yellow Brown Earth	37 (St-YBE)	12	12	0.25
Steepland-Podzolised-Yellow Brown Earth	37 (St-YBE)	12	12	0.25
Steepland-Yellow Brown Earth-Rendzina	37 (St-YBE)	12	12	0.25
Steepland-Northern-Yellow Brown Earth	37 (St-YBE)	12	12	0.25
Steepland-Yellow Brown Pumice +YBE	38 (St-YBPu + YBL)	12	10	0.40
Steepland-Recent +Yellow Brown Pumice	38 "	12	10	0.40
Steepland Yellow Brown Loam	38 "	12	10	0.40
Steepland-Recent/YBPu/YBL	38 "	12	10	0.40
Steepland-Podzolised-Yellow Brown Pumice	38 "	12	10	0.40
Steepland-Yellow Brown Loam	38 "	12	10	0.40
Steepland-Yellow Brown-Pumice	38 "	12	10	0.40
Steepland-Podzolized-Yellow Brown Loam	38 "	12	10	0.40
Steepland-Red Brown Loam	38 "	12	10	0.40
Steepland-YBPu + YBL	38 "	12	10	0.40
Steepland-YBL + Composites	38 "	12	10	0.40
Steepland-Recent + Yellow Brown Loam	38 "	12	10	0.40
Steepland-Yellow Brown Pumice/Yellow Brown Loam	38 "	12	10	0.40
Steepland-Brown Granular Clay + Loam	39 (St-BGrC)	12	7	0.40
Steepland-Brown Granular Clay	39 "	12	7	0.40
Steepland-Brown Granular Loam	39 "	12	7	0.40
Steepland-Recent	40 (St-Re)	12	16	0.10
Steepland-YGE/YBE	41 (St-YBE/YGE)	12	8	0.25
Steepland-YBE + YGE	41 "	12	8	0.25
Steepland-YBE/YGE	41 "	12	8	0.25
Steepland-YGE/YBE	41 "	12	8	0.25

* / = intergrades, + = composites, ** Yellow Brown Earths allocated to North- or central - YBE by geographical position: soil sets South of Hamilton were Central-YBE and North of Hamilton were classified as Northern-YBE.

Table 1.7

Pretentions for major soil groups of the North Island

Major Soil Group	Sources and P retentions	P retention No. in sample	Group P retention (estimated)
1. Re A Recent Alluvia	(a) 30 (c) 21 ± 3 (b) 7,10,13,28	6	19
2. Re Vo	(a) 47 (d) 16,56		40
3. Ra Rendzina	(d) 23,15,39		26
4. YGE	(b) 16 (c) 20 ± 1 (d) 24,25,32,27,14	27	21
5. YGE/YBE	(a) 14 (b) 54,13,20 (c) 24 ± 2	13	24
6. YBPu/YGE	(intermediate between YBPu and YGE)		(36)
7. YBPu	(b) 28 (c) 48 ± 3 (d) 63,70 (f) 28	34	48
8. YBPu + YBL	(intermediate between YBPu + YBL)		72
9. P-YBPu/YBL	(as central + Northern Podzols drop off 20-30% from YBE, assume similar decrease)		(45)
10. YBS	(b) 26 (c) 23 ± 5 (d) 0 (e) 25	12	22
11. N-YBS	(decrease of 13% C-YBE vs N-YBE- so quess some decrease YBS → N-YBS		(9)
12. G1-YBS			(29)
13. C-YBE	(b) 26,31 (c) 41 ± 3 (d) 24,31,59,40	29	40
14. C-P-YBE	(b) 91 (c) 11 ± 3	8	11

Table 1.7 continued

Major Soil Group	Sources and P retentions	P retention No. in sample	Group P retention (estimated)
15. N-YBE	(c) 31 ± 4 (d) 40,45	9	33
16. N-P-YBE	(c) 11.0 (d) 23	9	12
17. YBL	(b) 95 (c) 93 ± 1 (d) 62,95,89,92	11	91
18. P-YBL	(decrease 20-30% YGE→ P-YBE - assume similar here)		66
19. YBL/YBE	(b) 61 (c) 67 ± 5 (d) 92 (f) 61,36,89,89,89	11	70
20. YBL/BGrL			(70)
21. BGrL	(d) 42,56		49
22. N-BGrL	(see comments for C-YBE→N-YBE)		(36)
23. N-BGrL+P			(20)
24. YBE/BGrL	(intermediate YBE+ BGrL)		(41)
25. BGrLC	(c) 58 ± 6	7	58
26. BGrC	(d) 71,86		(79)
27. Br+R Loams	(c) 84 ± 5 younger 56 ± 4 older (d) 91,94,66,63	6 7	84 younger 56 older
28. G1	(b) 35		35
29. G1-Re	(a) medium P retention		35
30. G1-YBS			35
31. N-G1			(12)
32. O Organic	(d) 0 (f) 16		8
33. Sa-G1-Re			(20)
34. St	(same as for St-Re)		(20)
35. St-Ra	(same as Ra)		(26)
36. St-YBE	(c) 19 ± 2	9	19

Table 1.7 continued

Major Soil Group	Sources and P Retentions	P retention No.in sample	Group P retention(estimated)
37. St-YBE	(a) 20,25,32,25 (c) 25 ± 2	21	25
38. St-Vo,St-YBPu St-YBL,St-RBL	(same as for YBPu)		(40)
39. St-BGrC+L	(same as for BGrLC		(58)
40. St-Re	(same as for Re A)		(20)
41. St-YGE/YBE	(a) 17,29,14,27		22

P retentions: Sources quoted for N. Island Groups

(a) Campbell (1977).

(b) Rijske (1977).

(c) Saunders (1965).

(d) N.Z. Soil Bureau (1968).

1.8 Meat and Wool Board Economic Service sheep and beef farm classes

The correspondence between MWBES and soil sets was obtained for the South Island from N.Z. Soil Bureau (1968) where the present land use is described for each soil set (based on present use in 1968). The correlation between these two economic and land use classifications is shown in Table 1.8. Present land use described by N.Z. Soil Bureau (1954) for the North Island was done more than 30 years ago and could not be used. Present land use has also been described in the extended legend of the MWD Land Resource Inventory worksheets and this was considered suitable for classifying LUC's into Meat and Wool Board classes as is shown in Table 1.9. Where the present land use description was too brief, e.g. "semi-intensive", the vegetation present indicated whether the pasture was developed or undeveloped or whether there was scrub or some reversion.

Two regions (see Table 1.9) had estimates of present average stock carrying capacity of the LUC's in addition to some present use description and these were used in grouping the present land use descriptions of the North Island into the three Meat and Wool Board Economic farm classes. Intensive finishing farms (MWBES 5) correspond to intensive grazing at greater than 13 su/ha, and more intensive types of land use such as horticulture, cropping and dairying are included in this group. Easier hill country (MWBES 4) carries over 10 su/ha, and hard hill country (MWBES 3) carries about 9 su/ha or less.

Table 1.8 Correlation of South Island Meat and Wool Board Economic Service Sheep and Beef Cattle Farm classes with Land Use Intensity from Soil Bureau Bulletin 27

Soil Bureau Bulletin 27 Land Use Intensity		Meat and Wool Boards Economic Service, Sheep & Beef cattle Farm Classes
1	Very extensive farming	S.I. High Country
2	Extensive farming, breed.	S.I. Hill Country
3,4	Semi-extensive + fattening	S.I. Finishing Breeding
5	Intensive, all fattening	S.I. Intensive, finishing
6	Very intensive farming	S.I. Mixed finishing

* 10 = TP + TI (Indigenous + protection forestry)	probably areas unsuitable for pastoral use
* 11 = 0 (Wastelands, Reserves)	
* 12 = G (Protection grassland)	

* Numbers allocated to these present land use groups, for use in the data analysis. The dominant first land use for each soil set was selected but was not in agreement with pasture classes 1-7 of MWD set of data, as these soil sets were not recorded as having farming as the dominant use in Soil Bureau Bulletin 27.

Table 1.9 Present average stock carrying capacity of each land use as described by worksheets*, and Meat and Wool Boards' Economic Service classes of the land uses

North Island Present landuse from MWD Land Resource Inventory Worksheets	Average Stock rate su/ha	Number of LUC	S.D. of all C.C.	Meat and Wool Board classes
1. Intensive grazing + hort.				
2. Intensive grazing + cereals	14			
3. Intensive grazing + orchard and viticulture				5 Intensive - finishing farms
4. Intensive grazing + root & fodder crops	13.8	8	2.4	
5. Intensive grazing	12.8	35	1.9	
6. Intensive grazing to semi-intensive grazing	12.2	24	1.8	
7. Semi-intensive grazing	11.3	10	1.6	
8. Semi-intensive grazing to extensive	-	1	-	4 Easier hill
9. Semi-intensive grazing + undev. or reversion	10.3	32	2.5	
10. Extensive grazing	9.0	5	1.9	
11. Extensive grazing + undeveloped	7.0	12	3.3	3
12. Extensive grazing + undev. + scrub + reversion	7.8 v.low	28	2.2	Hard hill
13. Undeveloped	v.low			
14. Undeveloped (wet)	v.low			

* Regions 4 (Bay of Plenty - Volcanic Plateau), and 10 (Taranaki - Manawatu) only included.

1.9 Comparison of recent MAF data with data of 1977-79

Olsen P data, stocking rates and relative yields associated with the Olsen P data for the last three years are now available for comparison with the Olsen P data used in the present study, collected from the 1977-79 years and reported in Tables 1a and 1b. Olsen P data for the last three years are associated with stocking rates and relative yields that are close to those of the top farmer for soils with high producing pastures (Table 1.10). The potential farmer stocking rates (i.e. carrying capacity) also correspond closely with those for the high producing pastures of the South Island. It appears that farmers who use the soil testing service are farming or intend to farm at the top farmer stocking rates within most of the soil groups. Mean soil Olsen P levels from the two periods for the South Island major soil groups are similar (Table 1.10) with the only large difference occurring in soil group G, the brown granular loams and intergrades. This soil group however had high Olsen P levels in both sets of analyses.

1.10 Comparison of stock data (1980) from MWD estimates with census data

Prediction of P requirements using the model of Cornforth and Sinclair (1984) needed reliable estimates of stocking rates. Relative yield, pasture utilisation, animal loss factors have all been derived from the average, top and potential farmer stocking rates from Ministry of Works and Development (MWD) estimates, as discussed earlier. A check on the accuracy of MWD estimates of stocking rates and census data was possible (Table 1.11).

(a) Areas of land for pastoral use, census data compared with MWD data.
The areas of pastoral land (MWD) are less than the areas in the census data, possibly because MWD areas were only for Classes I-VII. Differences appear greater for South Island provinces where more Class VIII land could be expected.

(b) Comparison of stock units in provinces and totals.
There was an average difference of 1,031,000 with a standard deviation of +- 600,000 stock units for the North Island between the two sets of data for the provinces and 519,000 +- 400,000 for the South Island.

The overall difference between the two sets of stock data was only 578,000 stock units for the North Island and 100,000 for the South Island, so that there is close agreement between the two sets of data for North and South Island totals. Differences in the provinces are within acceptable limits, considering that other parameters used in the model for prediction of P needs are not accurately known (e.g. pasture utilisation, relative yield).

Table 1.10: Comparison of stocking rates, relative yields and Olsen P levels for all South Island soils in major soil groups from data used in the current study and recent data from MAF soil testing service.

Major Soil Groups*	Stock. rates of high prod. areas of current P study: average farmer	top farmer	potential farmer (c.c.)	stock. rates from recent MAF data: means of all soils	**potential (c.c.)	Relative yields from present P study: average farmer	top farmer	Relative yields MAF recent data (all stock rates)	Olsen P all soils from P study (from Table 1a)	Olsen P all soils recent MAF data	number (n) in recent MAF data
A	5.0	7.1	8.5	11.8	14.6	76.9	88.2	87.3	16.0	15.5	32
B	9.0	11.8	14.3	10.6	13.9	75.6	87.9	85.6	16.3	18.2	237
C	11.0	14.4	16.8	12.9	16.9	79.2	88.6	85.5	16.3	17.8	199
D	11.3	15.0	18.5	13.7	18.7	73.2	87.3	84.3	15.6	18.8	216
E	5.3	8.3	10.6	7.6	10.4	70.3	85.4	84.1	16.7	16.3	74
F	8.1	10.2	14.2	11.8	16.1	77.4	83.0	84.3	17.1	16.1	51
G	11.0	13.4	17.2	13.5	18.0	77.9	85.4	85.0	18.5	30.8	20
H	8.9	11.7	14.0	8.8	12.5	78.4	88.2	83.2	28.6	29.6	9
I	10.4	13.5	15.8	14.6	19.8	78.6	88.4	84.5	18.6	21.7	153
K	9.7	10.8	18.2	13.3	18.2	75.1	78.2	84.3	18.1	14.3	12
L	11.3	14.0	19.0	13.4	17.6	77.1	83.9	85.4	21.5	21.9	69
M	6.5	7.9	11.4	12.5	16.6	73.5	81.8	85.2	23.5	21.1	11
mean (not weighted for areas)	9.0	11.5	14.9	12.5	16.1	76.1	85.5	84.9	18.9	20.2	

* Major soil groups:
A = Brown Grey Earths, B = Yellow Grey Earths, C = Yellow Grey Earths-Yellow Brown Earths, D = Lowland Yellow Brown Earths, E = Upland and High Country Yellow Brown Earths, F = Upland and High Country Podsolised Yellow Brown Earths, G = Brown Granular Loams and Intergrades, H = Rendzinas, I = Recent Alluvia, K = Peats, L = Gleys, M = Yellow Brown Sands.

** Carrying capacity = $\frac{40 \times \text{stock. rate}}{(\text{Relative yield} - 55)}$

Table 1.11: Comparison of areas(ha) and stock units of each province of New Zealand from MWD ladeda data base and the Department of Statistics.

	M.W.D. stock and area data (1980)						Department of Statistics (1980/81)							
	grassland and cropland area (ha x 1000)		total	stock rate		total stock	area (ha x 1000)			*Stock units (x 1000)			crops grain	total
	high prod.	low prod.	area	high prod.	low prod.	units(x 1000)	land for grassland	land for crops grain and tree fruits & vines	total area	sheep(a)	dairy cattle(b)	beef cattle(c)	& tree fruit(d)	s.u. (x 1000)
Northland	694	51	745	10.3	8.9	7,602	715	7	722	2,058	1,981	3,254	79	7,372
Central Auckland Sth. Auckland Bay of Plenty	1,254	443	1,697	13.7	10.5	21,832	1,879	48	1,927	8,935	8,245	5,744	691	23,615
Central Auckland	338	15	353	11.7	8.9	4,089	307	12	318	979	1,335	1,288	151	3,753
East Coast	517	207	724	9.0	6.4	5,978	578	12	590	2,628	24	2,037	550	5,239
Hawkes Bay	527	349	874	11.4	8.9	9,091	955	26	981	7,001	290	2,958	309	10,558
Taranaki	330	199	529	15.0	8.8	6,701	466	4	470	1,532	2,923	946	11	5,412
Wellington	708	938	1,646	12.9	8.2	16,825	1,581	40	1,621	9,790	1,498	3,893	270	15,451
N. Island	4,366	2,201	6,567	12.1	8.7	71,978	6,480	149	6,629	32,923	16,296	20,120	2,061	71,400
Marlborough	112	323	435	8.4	2.7	1,813	708	41	749	1,299	121	553	195	2,168
Nelson	119	91	210	10.8	6.1	1,840	257	36	293	898	344	428	143	1,813
Westland	62	44	106	12.4	11.2	1,262	151	1	152	231	199	327	13	770
Canterbury	1,248	1,453	2,701	9.4	1.9	14,492	2,691	177	2,868	10,823	199	1,730	2,124	14,876
Otago	662	1,980	2,642	8.1	2.1	9,520	2,786	65	2,851	8,006	175	1,519	585	10,285
Southland	786	388	1,174	11.7	4.8	11,058	1,101	63	1,164	7,855	145	1,041	922	9,963
S. Island	2,988	4,277	7,265	9.8	2.5	39,975	7,693	329	8,022	29,112	1,183	5,598	3,982	39,875
New Zealand	7,354	6,478	13,832			111,953	14,174	466	14,640	62,035	17,479	25,718	3,555	111,275

* Goats, deer not included, 68,000 goats and 109,000 deer 1980/81.

(a) sheep numbers x .890 (value derived from Meat and Wool Board, N.Z. livestock numbers and stock units for 1979/80).

(b) dairy cattle x 6.04 (" " " " " " " " " " " " " " ").

(c) beef cattle x 5.03 (" " " " " " " " " " " " " " ").

(d) areas x stock rate of intensive fin. farms for each province (as above).

1.11 Summary

In this chapter the inputs needed for calculation of P requirements for maintenance and pasture establishment have been described. There were some differences between North and South Island data in method of analysing and the quality of data available. Some disadvantages of lack of North Island data (Olsen P particularly) will be discussed later, where it is suggested that lack of Olsen P data for the higher producing soils and lack of a good data base for low producing pastures may not be critical, as it appears that long term P needs for low producing North Island soils would be similar to first year needs.

The difference in defining the MWBES farm classes for North and South Islands will be discussed in the last chapter where stocking rates of each farm class will be compared with MWBES survey data for the 1980-81 year.

2. Phosphorus levels in NZ soils, effects of variables on P needs and relationships between variables

2.1 Present phosphorus status of N.Z. soils

This study involved the calculation of first-year P requirements and long-term requirements and these requirements can give an indication of the present phosphorus levels in the soils.

The present P status of soils can be indicated by the Olsen P and phosphate retention levels of the soils, and also by the difference between the first- year and long-term P requirements, calculated by the methods given in Chapter 1. If more P is required in the first year than for long-term then that soil is deficient in P for that level of production. Phosphate retentions and Olsen P levels are used in estimation of pasture establishment P, and high P requirements for this also indicates that a soil is low in P.

The first year P maintenance requirements at different stocking rates can be more or less than the long-term P requirements, depending on factors such as the Olsen P level in the soil and the desired stocking rates. Normally the first year P is applied in the first year, and the soil is again tested at a later date to determine whether the long-term maintenance P is needed. A large number of analyses for the South Island from the MAF soil testing service enabled a comparison of first year P requirements with long-term for South Island soils (grouped into 12 major groups) for soils with low producing and high producing pastures, as defined in Chapter 1. A limited number of analyses were also available for the North Island low producing pastures and comparisons between first year and long-term for low producing pastures for the North Island was possible.

2.1.1 Present P status of South Island major soil groups in relation to stocking rates

First year and long-term P needs for major soil groups are shown in Appendices 29-40. Stocking rates and Olsen P levels for these major soil groups for the high country are shown in Table 2.1, hill country, Table 2.2 and finishing - breeding farms Table 2.3. Major soil groups in which first year P needs are greater than long-term are indicated in these tables, and the following discussion relates stocking rate and Olsen P levels to the incidence of higher first year P demands than for long-term. For low producing soils where there has been no development and fertilisers,

pasture establishment P needs to be applied in the first year and subsequent fertiliser applied as described in 1.3. In some major soil groups the potential stocking rates on low producing pastures are markedly different from potential stocking rates on high producing pastures. This is because the soil sets that make up the high or low producing pastures are different and therefore the potentials of these major soil groups are different also.

2.1.2 Present P status of soils of the SI Meat and Wool Board Economic Farm classes

(a) Low producing pastures.
(1) Average farmer stocking rate - Where Olsen P levels are below 10.2 for any group of soils then more P is needed first year than for long-term. At Olsen P>10.6 less P is needed.

(2) Top farmer stocking rates - stocking rates increased an average of more than 50% (three major farm classes) from average to top stocking rates, and an Olsen P of 12.4 was needed before first year P requirements were greater than for long-term P.

(3) Potential farmer stocking rates - all major soil groups needed more P in the first year than for long-term even though Olsen P levels were >17.6.

(b) High producing pastures.
(1) Average farmer stocking rates - Where Olsen P levels were below about 11.0 then first year requirements were more than for long-term. Even though S.I. high producing stocking rates are considerably higher than those of the low producing, Olsen P levels for soils where there are greater first year P needs are not much different from Olsen P levels on low producing pastures where there are greater first year P needs.

(2) Top farmer stocking rates - Even at the higher stocking rates of high producing pastures only one major soil group needed more P in the first year, (peats, soil group K), tables 2.2, 2.3), than long-term P requirements.

(3) Potential farmer stocking rates - Where Olsen P levels were below about 19.5 soils needed more P in the first year. Even at the high relative yield (95%, as defined by Cornforth and Sinclair, 1984) the soils with higher levels of Olsen P did not need extra P.

Table 2.1: Stocking rates and Olsen P levels (weighted for areas) of low and high producing areas of the high country of the South Island for average, top and potential farmer stocking rates for major soil groups, *(first-year P requirements greater than long-term).

Soil Groups	Stocking rates on low producing			Olsen P unimproved	Stocking rates on high producing areas			Olsen P improved areas
	average	top	pot.		average	top	pot.	
A	1.5	1.7	2.5*	15.4	4.5	5.8	7.2*	14.4
B	2.1	3.4	5.2*	17.5	8.3	10.2	12.2*	15.3
C	5.2	7.3*	10.4*	10.8	3.6	5.2	8.6*	13.9
D	2.7	5.4*	7.2*	11.9	9.1	11.5	14.5*	15.4
E	0.6	1.2	2.0*	13.0	3.5	7.6	8.9*	17.4
F	0.6	0.6	1.5*	14.4	-	-	-	-
G	5.8*	9.0*	10.8*	8.9	8.4	11.5	13.7*	19.3
H	8.1	10.9*	12.9*	12.4	8.0	10.0	14.0	44.3
I	3.1	5.8*	7.6*	12.4	3.0	4.2	6.7*	12.6
L	4.7	7.8	13.0*	16.3	10.9	15.4	19.8*	16.4
M	2.1	2.6	7.7*	19.7	2.8	3.6	6.4*	20.8
wtd. average	1.6	2.8	4.1	13.9	7.4	9.7	12.1	15.5

MAJOR SOIL GROUPS A - BROWN GREY EARTHS B - YELLOW GREY EARTHS C - YELLOW GREY EARTHS-YELLOW BROWN EARTHS D - LOWLAND YELLOW BROWN EARTHS E - UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS F - UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS G - BROWN GRANULAR LOAMS AND INTERGRADES H - RENDZINAS I - RECENT ALLUVIA K - PEATS L - GLEYS M - YELLOW BROWN SANDS

Table 2.2: Stocking rates and Olsen P levels (weighted for areas) of low and high producing areas of the hill country of the South Island for average, top and potential stocking rates for major soil groups (*First-year P requirements greater than long-term).

	Stocking rates on low producing			Olsen P on unimproved	Stocking rates on high producing			Olsen P on improved
	average	top	pot.		average	top	pot.	
A	4.9	7.7	8.8*	15.9	5.2	7.9	9.2*	16.9
B	3.5	5.8	8.0*	14.4	6.9	9.5	11.6*	17.0
C	7.8	11.3*	14.0*	11.7	10.4	13.7	16.5*	17.1
D	4.5	7.6*	9.5*	11.2	10.9	14.7	18.1*	15.5
E	4.1	5.9	8.1*	15.5	6.5	9.3	11.7*	18.5
F	7.0	12.0	17.0*	16.0	7.0	12.0	17.0*	13.5
G	6.0*	7.8*	10.7*	9.5	10.4	12.3	17.0*	19.0
H	6.8	10.7*	12.7*	12.1	6.9	9.7	11.9*	25.9
I	7.0	9.4*	11.0*	11.6	7.3	9.6	11.1*	15.9
K	-	-	-	-	14.0*	17.0*	19.9*	10.5
L	6.8	7.0	15.7*	17.7	6.2	6.4	15.2*	20.4
M	3.7	4.2	6.8*	21.2	7.8	10.0	12.8*	23.2
wtd. average	4.6	7.1	9.2	13.3	8.2	11.0	13.6	17.0

MAJOR SOIL GROUPS A - BROWN GREY EARTHS B - YELLOW GREY EARTHS C - YELLOW GREY EARTHS-YELLOW BROWN EARTHS D - LOWLAND YELLOW BROWN EARTHS E - UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS F - UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS G - BROWN GRANULAR LOAMS AND INTERGRADES H - RENDZINAS I - RECENT ALLUVIA K - PEATS L - GLEYS M - YELLOW BROWN SANDS

Table 2.3: Stocking rates and Olsen P levels (weighted for areas) of low and high producing areas of finishing breeding farms of the South Island for average, top and potential stocking rates for the major soil groups (* First-year P requirements greater than long-term).

	Stocking rates on low producing			Olsen P	Stocking rates on high producing			Olsen P
	average	top	pot.	unimproved	average	top	pot.	improved
B	7.2	9.6	13.3*	12.9	9.6	12.9	15.6*	16.4
C	9.1*	12.2*	14.4*	10.2	11.7	15.1	17.4*	16.1
D	8.0	12.7*	16.1*	11.9	11.7	15.6	19.2*	16.4
E	2.0	2.0	8.0*	14.3	2.0	2.0	8.0*	19.6**
G	10.9*	14.1*	17.5*	10.1	14.1	17.1	20.1*	18.0
H	5.9	8.8	11.3*	14.1	9.8	12.8	15.2	28.6
I	10.6	15.4	18.0*	17.6	11.8	16.0	18.4	19.3
K	14.0*	17.0*	19.0*	10.0	14.0*	17.0*	19.9*	10.9
L	11.2	12.2*	19.3*	10.6	12.3	14.3	19.5	20.7
M	11.8	14.3*	18.0*	12.0	9.3	11.1	15.3	24.6
wtd. average	8.9	12.3	15.5	12.7	10.9	14.2	17.2	17.1

** E has high P retention (74), hence Fig 1C for high soil loss factors (Cornforth & Sinclair, 1984) applies for this soil group. However there are only 7135 ha improved soils of this farm class.

MAJOR SOIL GROUPS A - BROWN GREY EARTHS B - YELLOW GREY EARTHS C - YELLOW GREY EARTHS-YELLOW BROWN EARTHS D - LOWLAND YELLOW BROWN EARTHS E - UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS F - UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS G - BROWN GRANULAR LOAMS AND INTERGRADES H - RENDZINAS I - RECENT ALLUVIA K - PEATS L - GLEYS M - YELLOW BROWN SANDS

2.1.3 Significance of differences between first year and long-term P requirements for major soil groups and farm classes of the South Island.

(a) If the major soil groups marked in Tables 2.1, 2.2, 2.3 as needing more P in the first year only received their long-term requirements, what would be the shortfall in P applied for these South Island farm classes.

These extra requirements for these four major soil groups are shown in Table 2.4 and when these are compared with long-term P requirements (Table 2.5) the extra needs are small in comparison. On low producing SI high country pastures the difference amounts to 2.1% of long-term requirements at the average stocking rate and for all economic farm classes amounts to 2.9%. Differences between first year and long-term on high producing pastures at average and top farmer stocking rates amount to less than 0.2% of the long-term needs for all the S.I. farm classes. Differences between first year and long-term at potential stocking rates however, amount to 44% and 20% of low and high producing long-term P requirements respectively.

(b) Total differences between first year and long-term P requirements for the South Island.

The difference between first year and long-term P requirements for all soil groups at each stocking rate and farm class is given in Table 2.6. Less P is needed for all farm classes first year at average and top stocking rates, except for some low producing pastures at the top stocking rate where there was a small increase for first year compared to long-term for hill country, finishing-breeding farms and intensive-finishing farms.

2.1.4 Differences between first year and long-term P requirements for provinces of the South Island

(a) Low producing soils of S.I. provinces at average, top and potential farmer stocking rates.

Provinces where there are greater first year requirements than for long-term are shown in Tables 2.7, 2.8, 2.9 for the high country, hill country and finishing-breeding farms. The high country in Nelson and Westland and hill country and finishing-breeding farms in Southland need more P in the first year than for long-term at average stocking rates. The Olsen P of unimproved soils in these provinces are 11.6 or lower, with the exception of finishing-breeding farms in Marlborough where there was an

Olsen P of 9.6, but a low soil loss factor (0.12) compared with that for the other provinces (>.22). Soils with a low soil P loss factor need less P for an equivalent Olsen P than soils of higher soil P losses (Fig. 2a, Cornforth and Sinclair 1984). At top farmer stocking rates more P was required first year than for long-term in provinces with an Olsen P below about 13.7, except for Marlborough high country (Olsen P = 12.3) where first year P rates were about the same as those for long-term (4.3 and 4.7 kg P/ha respectively).

(b) High producing soils of S.I. provinces at average, top and potential farmer stocking rates (Tables 2.7, 2.8, 2.9).

There were no provinces where first year P requirements were more than for long-term at average and top farmer stocking rates, and Olsen P levels were all higher than 13.5. All provinces have greater first year than long-term P requirements at potential stocking rates except for Westland where Olsen P rates of developed soils were highest.

Table 2.4: Differences between first-year and long-term maintenance P requirements (Kg P x 1000) for major soil groups where first-year is greater than long-term, for the South Island Meat and Wool Board Economic Service farm classes for low and high producing soils at average, top and potential farmer stocking rates.

	Stocking rates		High country	Hill country	Finish. breeding farms	Intens. finish farms	Kg P diff. total
Soils with low producing pastures	average farmer	difference	114	127	81	0.6	322
		major soil groups	G	G	C,G,K	D	
	top farmer	difference	1,188	1,224	469	34	2,915
		major soil groups	C,D,G H,I	C,D,G H,I	C,D,G K,L,M	I	
	potential farmer	difference	7,248	5,945	2,072	144	15,410
		major soil groups	all groups	all groups	all groups	B,D,H,I	
Soils with high producing pastures	average farmer	difference	-	17	14	-	31
		major soil groups	-	K	K	-	
	top farmer	difference	-	38	45	24	106
		major soil groups	-	K	K	C	
	potential farmer	difference	1,583	2,787	8,489	908	13,767
		major soil groups	all groups	all groups	B,C,D,E G,K	B,C,D I,K	

MAJOR SOIL GROUPS A - BROWN GREY EARTHS B - YELLOW GREY EARTHS
C - YELLOW GREY EARTHS-YELLOW BROWN EARTHS
D - LOWLAND YELLOW BROWN EARTHS E - UPLAND AND HIGH HIGH COUNTRY YELLOW BROWN EARTHS F - UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS
G - BROWN GRANULAR LOAMS AND INTERGRADES H - RENDZINAS
I - RECENT ALLUVIA K - PEATS L - GLEYS M - YELLOW BROWN SANDS

Table 2.5: Total long-term maintenance P (Kg x 1000) for Meat and Wool Board Economic farm classes of the South Island for low and high producing soils for average, top and potential stocking rates.

	stocking rates	High country	Hill country	Finish breeding farms	Inten. finish. farms	Mixed cropping + finish. farms	Kg P total S. Island
Soils with low producing pastures	average farmer	5,352	3,863	1,619	174	0	11,008
	top farmer	9,511	6,481	2,461	234	0	18,687
	potential farmer	18,098	10,641	3,876	330	0	32,945
Soils with high producing pastures	average farmer	3,095	6,147	18,131	3,732	170	31,275
	top farmer	4,579	9,174	26,285	5,102	275	45,415
	potential farmer	7,092	14,109	38,795	7,250	357	67,603

Table 2.6: Differences between first-year and long-term maintenance P (Kg P x 1000) for South Island Meat and Wool Board Economic Service farm classes for low and high producing soils at average, top and potential farmer stocking rates.

	Stocking rates	High Country	Hill Country	Finish-Breeding farms	Intens. finish farms	Mixed Cropping + finish farms	Kg P difference total
Soils with low producing pastures	average farmer	-2,925*	-1,607	-438	-43	0	-5,013
	top farmer	-1,686	+619	+197	+13	0	-857
	potential farmer	+7,248	+5,945	+2,072	+135	0	+14,544
Soils with high producing pastures	average farmer	-2,310	-4,866	-12,078	-3,114	-83	-22,451
	top farmer	-875	-2,953	-6,981	-2,130	-45	-12,983
	potential farmer	+1,583	+2,787	+7,856	+398	+50	+12,674

* a negative value means that first-year is less than long-term, and a positive value, first year is more than long-term.

TABLE 2.7: Stocking rates and Olsen P levels (weighted for areas) of low and high producing areas in provinces in the high country of the South Island for average, top and potential stocking rates, *(first-year P requirements greater than long-term)

Provinces	Stocking rates on low producing areas			Olsen P	Stocking rates on high producing areas			Olsen P	Low prod. area (ha)	High prod. area (ha)
	Average	Top	Pot.	Low prod. areas	Average	Top	Potential	High prod. areas		
Canterbury	1.2	2.9	4.0*	14.0	8.1	10.2	12.3*	15.2	1,081,387	228,306
Marlborough	1.9	3.7	5.9*	12.3	4.1	6.4	10.0*	18.7	225,125	5,928
Nelson	5.1*	7.1*	9.8*	11.7	7.6	9.6	12.1*	13.5	38,799	11,273
Otago	1.4	2.1	3.4*	14.5	4.0	5.2	7.4*	14.6	1,551,716	98,384
Southland	3.1	4.2*	6.3*	12.1	7.7	10.5	13.6*	17.7	230,959	75,054
Westland	11.6*	17.5*	20.3*	11.6	12.6	18.8	21.8*	15.3	5,149	31,188

TABLE 2.8: Stocking rates and Olsen P levels (weighted for areas) of low and high producing areas in provinces of the hill country of the South Island for average, top and potential stocking rates, *(first-year P requirements greater than long-term)

Provinces	Stocking rates on low producing areas			Olsen P low prod areas	Stocking rates on high producing areas			Olsen P high prod areas	Low prod area (ha)	High prod area (ha)
	Average	Top	Pot.		Average	Top	Pot.			
Canterbury	3.5	5.6*	7.4*	13.1	7.3	9.9	11.9*	16.6	290,147	307,677
Marlborough	4.0	8.2	11.1*	13.4	6.2	10.3	14.5*	17.7	79,817	22,774
Nelson	7.5	11.0*	14.2*	12.6	12.2	17.5	20.2*	16.2	18,414	24,478
Otago	4.8	7.1*	9.1*	13.7	6.5	8.9	11.9*	17.3	335,915	200,610
Southland	9.7*	12.4*	14.9*	10.9	11.3	14.4	17.4*	17.4	43,699	170,258
Westland	12.4	17.8	21.6*	17.9	12.0	17.1	20.9*	19.1	5,878	3,928

Table 2.9: Stocking rates and Olsen P levels (weighted for areas) of low and high producing areas in provinces of the finishing breeding farms of the South Island for average, top and potential stocking rates *(first-year P requirements greater than long-term).

Provinces	Stocking rates on low producing areas			Olsen P low prod	Stocking rates on high producing areas			Olsen P high prod	low prod	high prod
	average	top	pot.	areas	average	top	pot.	areas	area(ha)	area(ha)
Canterbury	7.6	10.4*	12.7*	11.7	10.4	13.6	16.1*	17.0	44,534	604,102
Marlborough	7.3	11.5	16.4*	9.5	8.6	13.4	17.8*	15.9	12,706	64,983
Nelson	10.9	16.7	19.7*	15.4	10.7	16.4	19.8*	19.7	12,556	68,548
Otago	7.6	10.2*	13.3*	12.0	10.2	13.5	16.3*	16.2	40,424	335,037
Southland	10.6*	13.1*	17.4*	10.2	12.4	15.3	18.8*	17.6	26,593	398,035
Westland	12.2	17.9	21.1*	20.0	12.3	18.4	21.5	23.5	18,990	23,142

Table 2.10: Stocking rates and areas of low and high producing soil of MWBBS farm classes of the North Island in provinces at average, top and potential farmer stocking rates.

	Stocking rates (s.u./ha)						Areas (ha)	
	low producing			high producing				
	av.	top	pot.	av.	top	pot.	High prod	Low prod
Hardhill country	6.9	9.0	11.1	7.9	10.1	11.8	109,017	808,738
Easier hill "	9.3	12.6	15.1	9.9	13.3	15.6	1,284,671	1,093,559
Intensive - finishing farms	11.4	14.9	19.2	13.3	18.0	22.5	2,972,387	299,028

2.1.5. P status of North Island soils

North Island stocking rates on soils of low producing pastures soils were not much less than those on high producing areas (Table 2.10). These low producing pastures may therefore have been receiving some fertiliser P to have been maintained at those high stocking rates. Earlier comparisons of MWD stock estimates with census data showed reasonable agreement, so that it is likely that MWD estimates of carrying capacities for both the low and high producing areas are valid, but the low producing pastures also probably included some better land that has been fertilised. However, Olsen P values (of virgin soils mostly) for the major soil groups of the North Island are included in Table 2.11 for the major soil groups of hard hill, easier hill and intensive-finishing farms respectively, although there is some doubt whether these Olsen P values correspond to the low producing areas in the above tables.

However, if it is assumed that Olsen P values of virgin soils apply for North Island low producing pastures, then there are only two major soil groups (recent and rendzina (limestone) soils) where there is less P needed in the first year and Olsen P levels of these were above 14.0. It appears that P levels in N.I. undeveloped soils are low, as indicated by the Olsen P levels. However, at potential farmer stocking rates all major soil groups in the North Island need more P in the first year than for long-term on the low producing soils. North Island soils do appear to be more deficient in P than the South Island soils as shown by the lower North Island Olsen P levels. More confidence would be put in the above statement if there was an independent check on the derived Olsen P levels. There are two means of testing the validity of the North Island Olsen P data.

(a) A previous comparison (see Chapter 1) of Olsen P analyses from the MAF soil testing service and another set of analyses (Soil Bureau results mainly) showed that the two sets of data predicted quite similar responses to P fertilisers on undeveloped S.I. soils. A similar set of soil P analyses (mainly Soil Bureau data) was used to derive the North Island Olsen P data and the above agreement in the two sets of data would support the validity.

(b) Another means of checking North Island Olsen P levels is possible through a relationship between the Olsen P and P retentions for soils of both North and South Islands as shown in the next section.

Table 2.11: Stocking rates and Olsen P level (weighted for areas) of low prod. areas of the North Island for average, top and potential stocking rates for major soil groups and MWBES farm classes, *(first-year P requirements greater than long-term).

Major Soil group	Hard Hill			Easier Hill			Intens. Fin. Farms			Olsen P (undeveloped)		
	average	top	pot.	average	top	pot.	average	top	pot.	Hard Hill	Easier Hill	Intens. Fin. farms
1	3.4	4.7	6.2*	10.0*	12.0*	12.1*	10.7	14.1	20.1	14.0	12.1	19.2
2	7.0	11.0	14.0*	-	-	-	-	-	-	19.0	-	-
3	10.0*	12.3*	14.4*	9.7*	14.1*	17.5*	10.7*	14.3*	19.4*	7.6	7.4	7.0
4	6.7*	7.9*	10.3*	10.3*	12.5*	15.4*	12.7*	16.0*	18.5*	11.0	11.0	11.0
5	5.1*	8.0*	10.4*	6.7*	10.5*	15.8*	12.1*	15.8*	22.2*	7.8	7.5	6.7
6	9.8*	12.5*	14.8*	9.2*	13.2*	15.8*	10.5*	14.0*	18.6*	11.1	10.3	10.2
7	7.5*	10.5*	12.3*	10.3*	13.7*	16.4*	11.6*	15.2*	19.0*	9.9	10.0	10.0
8	9.6*	13.3*	15.8*	10.7*	14.2*	17.1*	12.2*	16.3*	20.0*	9.0	8.5	9.0
9	9.7*	13.4*	15.9*	9.6*	12.7*	15.4*	12.5*	17.0*	19.6*	7.0	6.8	5.8
10	-	-	-	11.3*	14.1*	12.5*	13.0*	14.9*	16.3*	-	8.0	8.0
11	7.0*	10.4*	8.3*	9.0*	13.3*	15.3*	13.2*	16.9*	24.3*	10.3	9.1	9.2
12	6.1*	8.1*	10.3*	8.1*	11.2*	12.8*	8.3	11.6*	15.4*	10.8	11.0	12.4
wtd. average										10.4	10.1	10.5

MAJOR SOIL GROUPS 1 - RECENT SOILS 2 - RENDZINA SOILS 3 - YGE & INTERGRADES 4 - YBPU & VOLCANIC INTERGRADES
5 - YBSANDS & VOLCANIC INTERGRADES 6 - YBE - N & CENTRAL 7 - YBL & INTERGRADES
8 - BROWN GRANULAR LOAMS 9 - BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS
10 - BROWN & RED LOAMS 11 - GLEYS & ORGANIC SOILS 12 - STEEPLAND SOILS

2.2 Relationship of Olsen P and P retention values

North and South Island Olsen P (North Island derived values) for undeveloped soils and P retentions showed similar negative correlations (Fig.2.1). There was a significant negative correlation for the South Island in the regression of

$$y = 18.72 - .18x$$

y = Olsen P, x = P retentions, r = .81, Sig. p<or = .01.

North Island data showed a similar relationship (y = 14.97 - 0.09x, r = 0.53, which was not however significant). Peats were omitted for the South Island data as there were high P retentions (44.0) and Olsen P levels (43.9). Yellow-brown sands were omitted from the North Island data; Olsen P levels should have been higher in relation to the P retention as sandy soils could be expected to lose nutrients (leaching etc.), in addition to losing P by immobilisation. The mean area weighted Olsen P for North Island yellow-grey earths (7.39) was also too low and as there was some doubt about the possible Olsen P levels for this group (Table 1.4), it was also omitted from the regression.

The above relationship of Olsen P to P retention could also indicate the significant effect that P retention properties of a soil have on losses of P, and it will be discussed later how the soil loss factor is one of the the major factors affecting efficiency of P use. P retentions of North Island soils range from 10-85 while those of the South Island range from 9-61 (Fig 2.1). Soil P loss factors were not correlated with Olsen P levels of undeveloped soils. Only three levels, 0.1, .25 and 0.40 were used for soil loss factors, and although soil loss factors are related to P retentions (Cornforth and Sinclair 1984) there was no significant relationship to Olsen P.

Phosphate retentions also are important in determining pasture establishment P requirements. The relative importance of P retentions in the North and South Island is shown in Table 2.12; P retentions in the North Island are 8.8 units higher than those in the South Island, Olsen P values are 3.4 units lower, and P requirements for pasture establishment on low producing pastures are about double those needed for the South Island. The amounts of P needed for pasture establishment if all low producing pastures needed establishment P for South Island MWBES farm classes in provinces are shown in Appendices 22-28 and in Appendices 48-52 for the North Island.

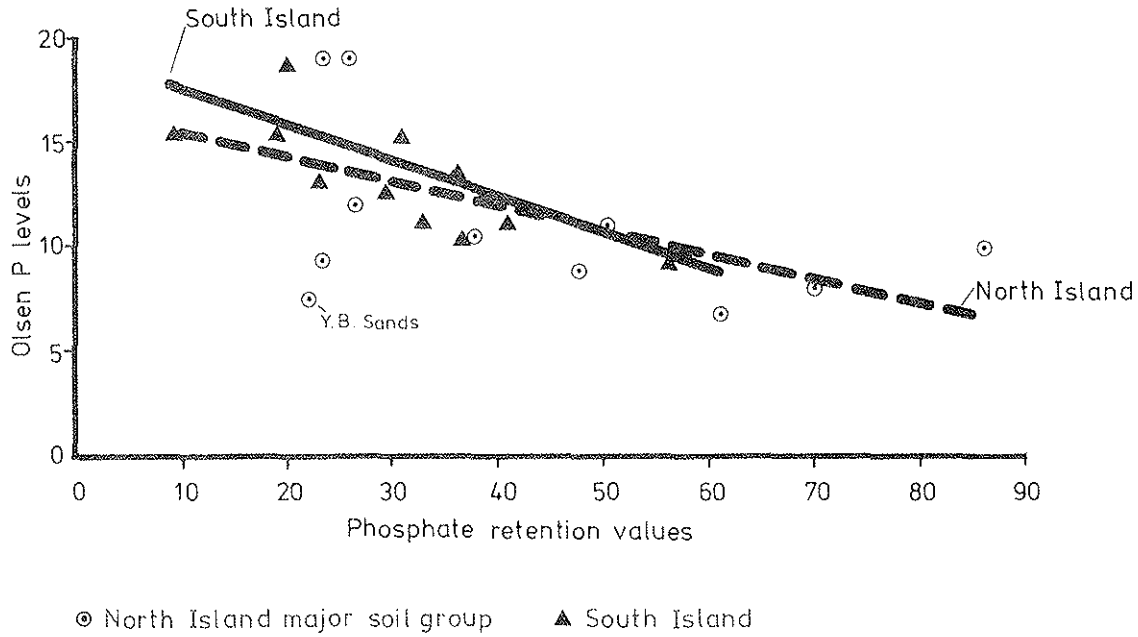


Fig. 2.1 Regressions of Olsen P levels and phosphate retention levels for South and North Island unimproved soils with averages for major soil groups also shown.

TABLE 2.12: Areas of low prod. soils, Olsen P values, average P retention and pasture establishment P (kg/ha) for unimproved in provinces of New Zealand.

Province	Low producing areas (hectares)	P retention of unimproved	Olsen P	Pasture estab. P (kg/ha)
Auckland	15,297	27.6	9.7	22.0
Bay of Plenty	442,872	50.3	10.5	66.5
East Coast	206,756	33.1	11.3	28.3
Hawkes Bay	348,654	28.8	9.8	21.9
Northland	51,412	36.9	8.8	39.2
Taranaki	198,803	54.7	11.1	56.1
Wellington	937,531	35.3	10.0	30.6
NORTH ISLAND	2,201,325	38.8	10.3	38.7
Canterbury	1,453,357	26.7	13.7	12.3
Marlborough	320,122	25.2	12.5	13.0
Nelson	91,180	35.1	12.5	19.1
Otago	1,979,740	29.7	14.3	13.4
Southland	388,225	46.3	11.8	31.1
Westland	43,958	28.8	16.4	9.5
SOUTH ISLAND	4,276,582	30.0	13.7	14.7

2.3 Further comparisons of North and South Island and summary.

Olsen P levels of the South Island low producing pastures of major soil groups were moderately high as shown by the small needs of major groups of soils for increases in the first year over long-term requirements. Olsen P levels of low producing pastures were not available and values for undeveloped soils were used instead. Olsen P values for low producing pastures would probably be higher than those for undeveloped soils. There were certain levels of Olsen P when first year needs were greater than long-term for average and top farmer stocking rates, regardless of the stocking rates. Olsen P levels of developed soils were considerably higher than those for undeveloped (Olsen P where no P has been applied) and there were no increases needed for the high producing soils except for peats at average and top farmer stocking rates. At potential farmer stocking rates almost all soils need more first year than for long-term, and usually large increases are needed.

Relative yields (pasture production as percentage of the maximum) are also used in calculating first year P needs (modifying factor calculation from Fig. 2, Cornforth and Sinclair 1984), and higher relative yields could expect to require greater first year needs than for long-term. However, it was shown earlier for North and South Islands that Olsen P levels were the dominant factor within the farm classes. Relative yields are calculated from the stocking rates in this study, and hence follow trends in stocking rates closely. The average, top and potential stocking rates are shown in Fig.2.2. South Island stocking rates for hill and high country low producing pastures are mostly lower than for any other farm classes. The relative yields (Fig. 2.3) for average stocking rates on South Island hill and high country are considerably lower than for other farm classes; however, the top farmer stocking rates on low producing pastures are equal to those at average stocking rate on high producing pastures so that it appears that higher relative yields on hill and high country low producing pastures should be possible if more fertiliser P was added. Percentage relative yields for the three economic farm classes of the North Island were similar with slightly higher relative yields for easier hill than for hard hill and intensive finishing farms (Fig. 2.3); differences were small however, between the farm classes both for low producing and high producing soils. While relative yields in the South Island followed the trends in stocking rate closely (Fig. 2.2 and 2.3), the stocking rate trends in the North Island did not have similar effects on

relative yields. It appears that for the North Island, relative yields are high at each of the stocking rates but for the South Island relative yields are low at lower stocking rates. There appears to be potential for increasing relative yields on South Island hill and high country.

As expected pasture utilisation (which has also been calculated from relative yields using the equation given in chapter 1) follows similar trends as for relative yields (Fig. 2.4). It will be important in the next chapter on possibilities in management of phosphate resources to try to determine whether an area has low relative yields, low pasture utilisation, or both. There are apparently quite large differences in both pasture utilisation and relative yields between the average and top farmer stocking rates. Both pasture utilisation and relative yields of North Island soils are high (Fig. 2.3, 2.4) and there may be less potential for increases in either as there would appear to be in the South Island hill and high country.

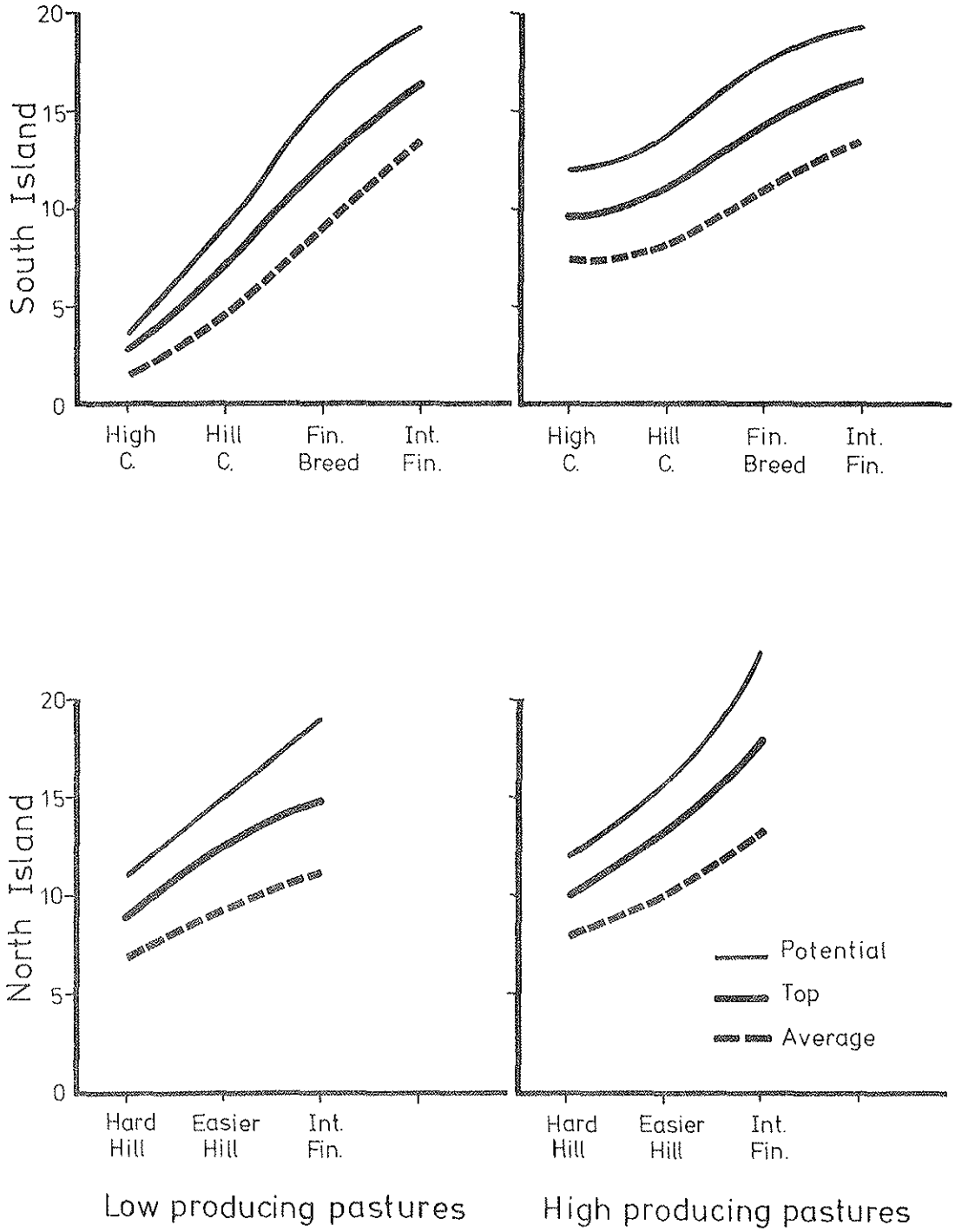


Fig. 2.2 Average, top and potential farmer stocking rates for low and high producing soils in MWBES farm classes of North and South Islands. (su/ha)

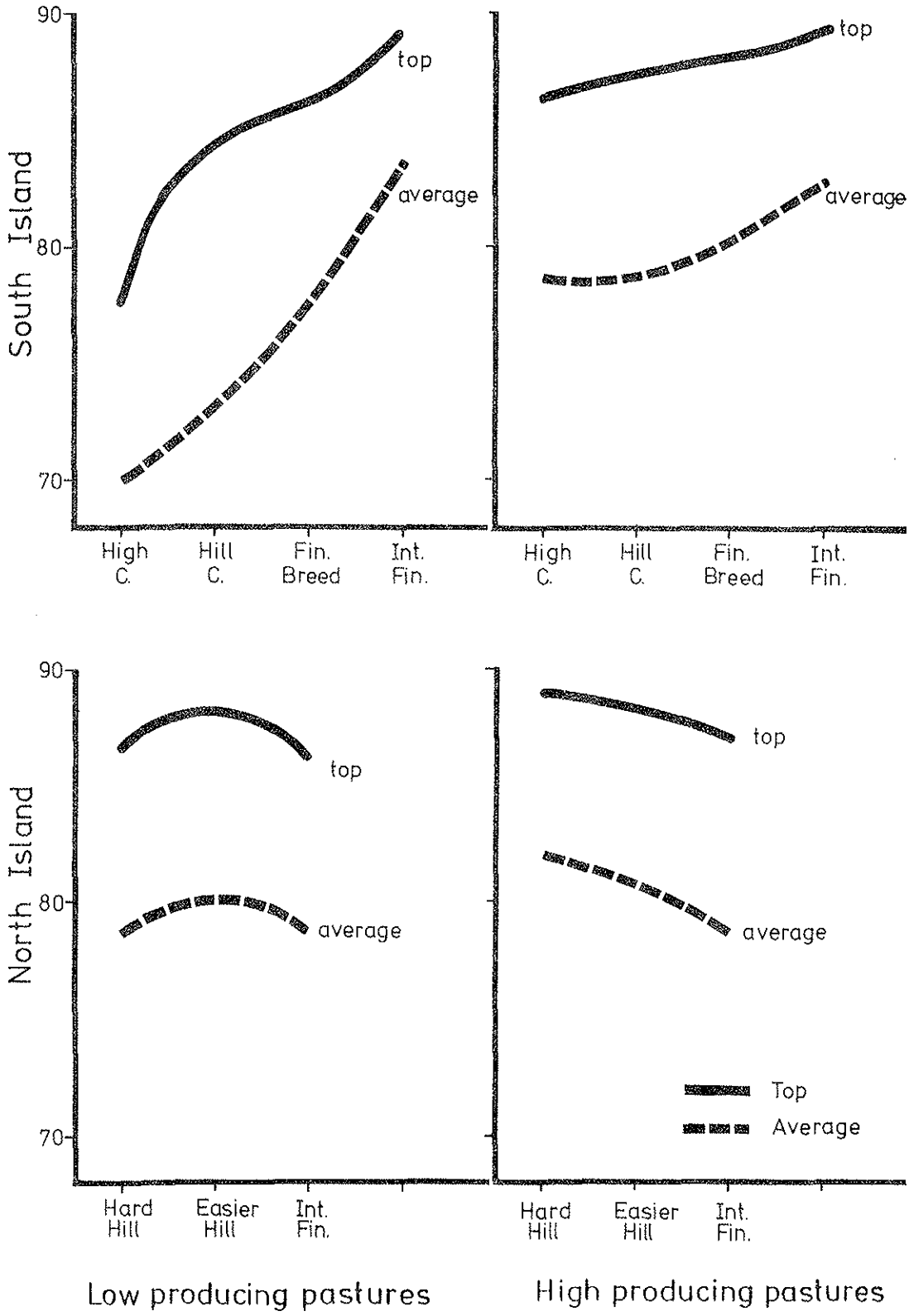


Fig. 2.3 Percentage relative yields of average, top and potential farmer stocking rates for low and high producing soils in MWBES farm classes of North and South Islands.

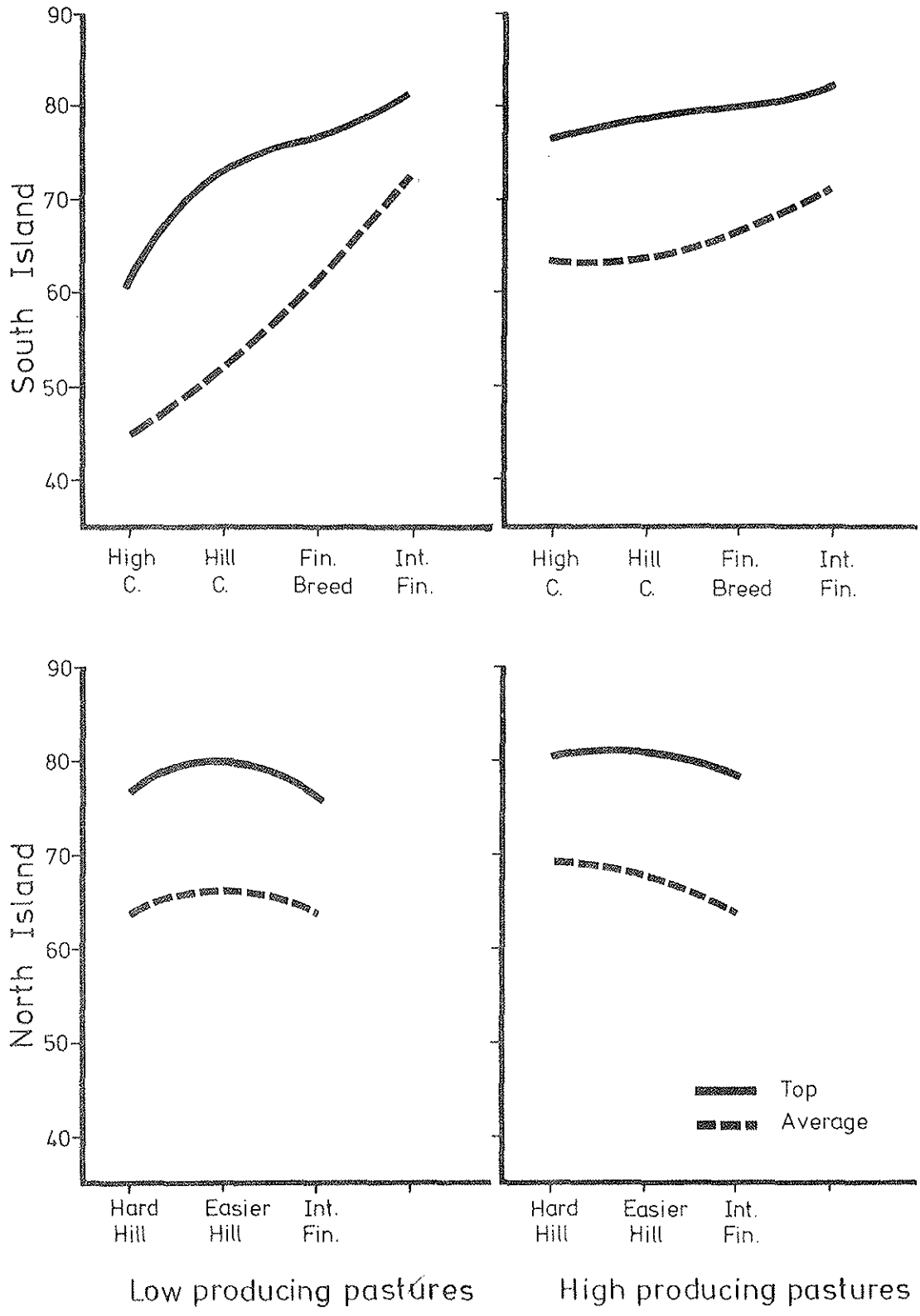


Fig. 2.4 Percentage pasture utilisation of average, top and potential farmer stocking rates for low and high producing soils in MWBES farm classes of North and South Islands.

3. Management of fertiliser resources

This chapter covers management options available in the use of P fertiliser and investigates some factors causing inefficiences of P use.

3.1 Management options in fertiliser use

There are several management options in fertiliser use according to Cornforth and Sinclair (1984). These involve varying pasture utilisation, stocking rates and fertiliser use. Increasing fertiliser use will increase relative yields of pasture.

Pasture utilisation and relative yield have been defined earlier in section 1.

Longer term strategies suggested by Cornforth and Sinclair (1984) were

(a) maintain current practice
(b) increase pasture utilisation and cut fertiliser use at constant stocking input
(c) increase pasture utilisation and stocking rate at constant fertiliser input
(d) increase stocking rate and fertiliser use at constant pasture utilisation.

Pasture utilisation can be assessed by the above relationship or can be used as an independent variable, keeping the stocking rates constant.

3.1.1 South Island low producing pasture soils

The P requirements in kg P/stock unit for South Island low producing soils are shown in Fig. 3.1 for a range of stocking rates and pasture utilisations. The amount of P needed for each stock unit could be an indication of P input needs per unit of output. For each curve, pasture utilisation was used as an independent parameter in addition to the average and potential stocking rates.

Increasing pasture utilisation from the present 52.4% on soils of low producing pastures to 60% at the same rate of P/su gives an increase of 0.6 su/ha at 1.0 kg P/su. This would be an increase of 2.57 million stock units or 3.6% for the South Island low producing pastures area for the

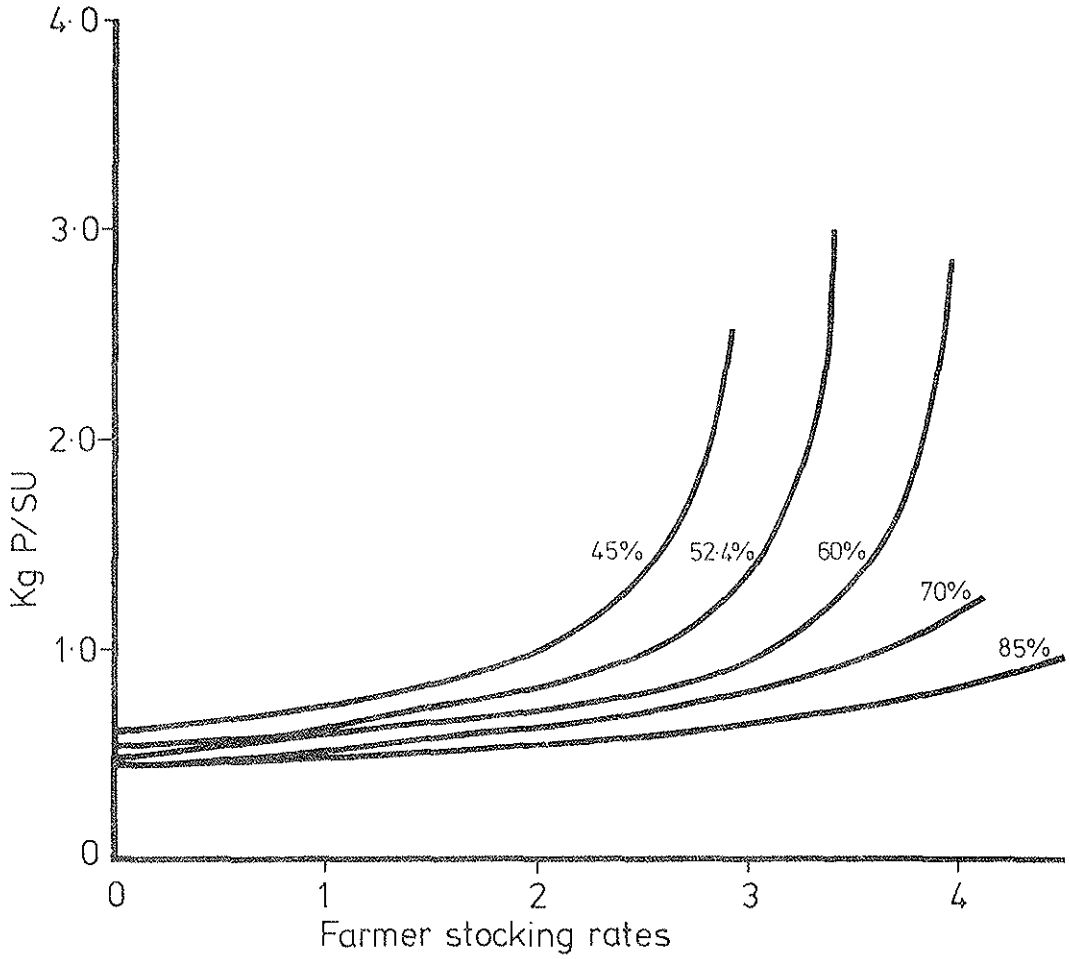


Fig. 3.1 Efficiency of phosphate use (kgP/s.u.) for South Island low producing soils at different stocking rates and pasture utilisations. Present South Island pasture utilisation (52.4%) calculated from 2.5 s.u./ha at th average farmer stocking rate and 5.6 s.u./ha potential farmer stocking rate and pasture utilisation as an independent parameter at varying average and top farmer stocking rates.

increase of 7.6% pasture utilisation, without any increase in fertiliser application.

At the same average stocking rate, an increase of pasture utilisation from 52% to 85% would decrease P fertiliser needs from 1.0 kg P/su to 0.6 kg P/su; this reduction would thus be achieved by improving pasture utilisation. Costs of increasing utilisation or relative yield could be compared for the most profitable alternative.

Other combinations of possible changes in fertiliser use, pasture utilisation and stocking rates could be demonstrated. At the present stocking rate on low producing South Island soils, P needs at present are on the increasing rate part of the curve for 52% pasture utilisation; a slight decrease in pasture utilisation would produce a sharp increase in P required/stock unit.

As these low producing soils may not be at present having any P applied (low producing soils defined as MWD inventory map units with no high producing pasture present), then actual stock performance would probably be less than that described in Cornforth and Sinclair's model and/or the soils are being depleted of P by up to 2.8 kg P/ha/yr. About 0.5 kg P/su are needed regardless of stocking rate or pasture utilisation as there are other losses such as P losses in the soil that are present in all situations. Even at high P fertiliser rates, stocking rates can only be increased by a small amount if pasture utilisation is not increased. A maximum of about 3.5 su/ha can only be achieved at the 52% pasture utilisation (potential at 5.6 su/ha, achieved at 95% pasture utilisation and 95% relative yield).

3.1.2 South Island high producing pasture soils

If pasture utilisation is increased from the present 67% to 80% at 9.8 s.u./ha then fertiliser needs are reduced from 1.04 kg P/su to .80 kg P/su (Fig. 3.2). If fertiliser use is held constant at 1.04 kg P/su, then the stocking rate would increase from 9.8 su/ha to 12.3 at 80%. More P is needed for the top stocking rates than at the average stocking rates (1.17 kg P/su for top and 1.04 kg P/su for average), with top pasture utilisation of 79%. If the stocking rate at the top farmer level was reduced by 0.5 su/ha, then the same P/su would be needed for average and top stocking rates on high producing areas.

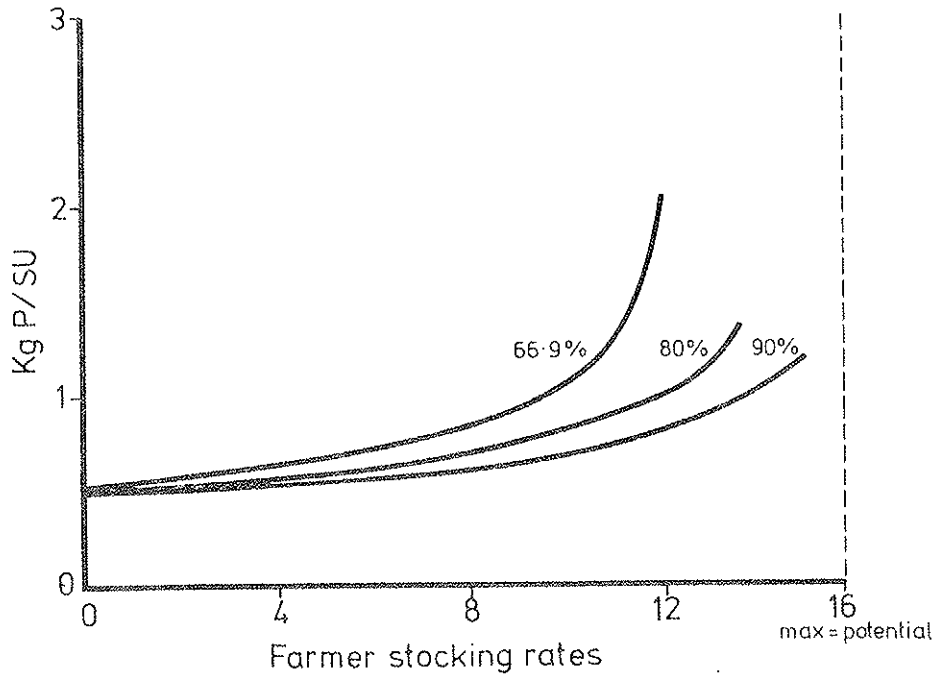


Fig. 3.2 Efficiency of phosphate use (kgP/s.u.) for South Island high producing soils at different socking rates and pasture utilisations. Present South Island pasture utilisation (66.9%) calculated from 9.8 s.u./ha at the average farmer stocking rate and 15.7 s.u./ha potential farmer stocking rate and pasture utilisation as an independent parameter at varying average and top farmer stocking rates.

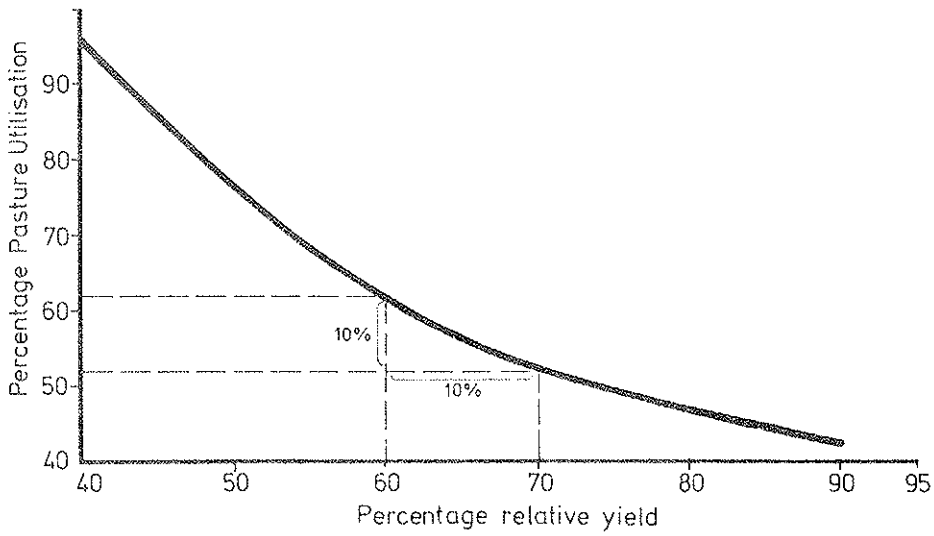


Fig. 3.3 Relationship between percentage pasture utilisation and percentage relative yield for South Island low producing soils calculated from Cornforth and Sinclair (1984) for the South Island weighted average of an average farmer stocking rate of 2.5 s.u./ha and potential farmer stocking rate of 5.6 s.u./ha.

It is also clear from Figures 3.1 and 3.2 that at the potential farmer stocking rates, needs of P/su would be high. Such high P rates (e.g. 23 kg P/ha for SI high producing pastures, or 290 kg super/ha/yr) could increase chances of pollution of waterways. In this regard, increasing pasture utilisation, and spreading development to those soils which are not near the potential would use less P per stock unit and be less of a risk in causing pollution. Cornforth and Sinclair (1984) have suggested that dairying should be at the 90-95% relative yield which would require high P rates/ha. Pasture utilisation would need to be high with high relative yields, otherwise the extra feed grown would require very high amounts of P/su.

At the average and potential stocking rate for South Island low producing areas, with pasture utilisation and relative yield determined by the equations given earlier, an increase of 10% pasture utilisation would decrease the need for increasing relative yield by 10% as shown in Figure 3.3. The cost of increasing the relative yield by 10% could be compared with the cost of increasing pasture utilisation by 10%, and the preferable course of action could be chosen. Increasing pasture utilisation should often be the preferred option, for the cost benefits, for the more efficient use of P resources, and better grazing management of pastures which would maintain herbage in a vegetative state of better feed quality. The same relationship of pasture utilisation and relative yield exists for North Island low producing areas, even though pasture utilisation is higher than for the South Island.

Sinclair and Cornforth (1984) suggest that relative yield must not be allowed to fall too low, otherwise the species composition and quality of pastures are likely to decline through the ingress of low fertility species.

Since the Olsen P levels of a large proportion of the high producing and low producing pastures on South Island soils are not low, relative yields at least as affected by the supply of the variable P must be reasonable. The yellow grey earths of low and high producing soils in the South Island are in the medium range (Olsen P of 16.3 and 14.6 respectively, results Ch. 2). Another possibility that has been suggested (K.F. O'Connor, pers. comm.) has been the influence of sulphur. If sulphur (and not P) was the limiting factor particularly on these yellow grey earths, and relative

yields of South Island low producing soils were lower, e.g. by 10% than expected, then pasture utilisation would be higher by that amount.

As an example the yellow grey earth soils of the South Island high country had a predicted relative yield of 69.8 at the average stocking rate of 2.05 su/ha and a potential stocking rate of 4.19 su/ha. P needs are 1.82 kg/ha long-term and .44 kg P/ha short-term. If the relative yield was reduced to 60% then pasture utilisation would not be at present 48%, but would be 56%.

The example of the yellow grey earth soils of the high country is an interesting example. What are the reasons for the estimated low pasture utilisation of low producing areas? Is it some agronomic factor such as a lack of suitable quality feed of clovers to encourage utilisation, or lack of subdivision and the effect of more extensive management. Winters in the South Island high country are a bottleneck on stock carrying capacity so perhaps lack of stock in the pasture growing season could mean that herbage could not be used while still at a vegetative stage of growth before seeding. The sulphur level in soils mentioned earlier may be a restricting factor to relative yield (or pasture utilisation), since Olsen P levels are not low for the yellow grey earths (Ch. 2, Table 1.1). Sinclair and Cornforth (1984) suggested pastures would deteriorate unless the 75% relative yield was maintained when S.R./C.C = 0.5; this situation is probably present on the yellow grey earth soils of the high country, with a predicted relative yield of 69.8%. It seems unlikely that P is the limiting factor, both because of the present Olsen P level and the low P requirements short-term of only .44 kg P/ha. Moreover it would also be difficult to distribute evenly .44 kg P (5.5 kg super phosphate) over the hectare, and would probably be too uneven to effect an increase in relative yield.

3.2 Factors affecting fertiliser needs per stock unit

One indicator of relative efficiency of fertiliser use is the P required for each stock unit and where there is low pasture utilisation, the kg P/su can be higher, through the relationship shown in Figs 3.1 and 3.2. Where the pasture utilisation is very low in some of the provinces, the kg P/su is high compared to the average for the major soil group (Table 3.1).

Soil loss factors are higher for North Island soil groups than for the South Island (Table 3.2, 3.3). Soil loss factors in five of the 12 groups

are at 0.40 or .38, and the amounts of P needed per stock unit at the average farmer stocking rates for all these major soil groups were high. The soil P loss factors and kg P/su for the North Island soil groups were also closely related (r^2 = .86).

There is also a wide range of slopes in the North Island soils (Table 3.3). Calculations show that about 21% more of the applied P per hectare is lost on steep areas compared to flat areas, so that fertiliser P applied to flatter areas will be used more efficiently. However the recent soils (Group 1) and the red and brown loams (Group 10) are the only soils in the North Island that are near flat, and the latter group also has a higher soil loss factor.

Table 3.1 : Comparison of Kg P/SU and Pasture Utilisations of Soil Groups in Provinces Compared with Means for Soil Groups in the South Island, at average farmer Stocking Rates.

Soil Group		Provinces	Kg P/SU	Average pasture utilisation of low producing area	Low prod. area (ha)
Yellow grey earths	B	Southland	1.26	36.7	13,962
	B	All South Island	.93	45.5	989,792
Lowland yellow brown earth	D	Marlborough	2.03	19.2	101,429
	D	All South Island	1.33	42.4	646,794
Upland and high country yellow brown earths	E	Marlborough	1.38	39.7	70,673
	E	Westland	1.95	14.5	105
	E	All South Island	1.17	44.6	1,831,685
Peats	K	Southland	3.09	35.4	6,659
	K	All South Island	2.14	52.1	13,437

Table 3.2 : South Island Soils (low prod.) pasture utilisations, kg P/su at average farmer stocking rates, soil loss factors and low producing areas (ha).

Major soil groups	Pasture utilisation	Kg P/SU average	Soil loss factor	Low producing area
A	58.2	.73	.10	158
B	45.5	.93	.16	989
C	56.5	1.21	.25	162
D	49.7	1.33	.25	647
E	43.2	1.17	.25	1832 *
F	58.6	1.08	.25	45
G	59.5	1.46**	.37	129
H	59.8	1.22	.25	26
I	55.6	.85	.15	197
K	52.1	2.14**	.40	13
L	48.2	1.24	.25	49
M	47.2	1.41	.25	28

*largest area - Upland + H.C. YBE's

** G - BGL - YBE + intergrades)
K - Peats) high kg P/SU in Provinces

Major soil groups A=Brown grey earths, B=Yellow grey earths, C=Yellow grey earths-Yellow brown earths, D=Lowland yellow brown earths, E=Upland and high country yellow brown earths, F=Upland and high country podsolised yellow brown earths, G=Brown granular loams and intergrades, H=Rendzinas, I=Recent alluvia, K=Peats, L=Greys, M=Yellow Brown sands.

Table 3.3 : North Island Soil Groups (low producing) pasture utilisation and kg P/su needs (average farmer stocking rates), soil loss factors and animal loss factors.

Major soil groups	Pasture utilisation (a.s. Rate)	S.L.F. of low prod. areas	A.L.F. (slope related)	Average kg P/SU of low prod. pastures
1	56	.18	.76	.91
2	57	.25	1.1	1.39
3	64	.22	.90	1.25
4	69	.28	.84	1.33
5	55	.38	.81	1.55
6	64	.25	.90	1.31
7	65	.40	.88	1.61
8	66	.40	.96	1.71
9	67	.40	.90	1.65
10	81	.40	.77	1.65
11	65	.31	.72	1.38
12	65	.27	1.08	1.40

r^2 of regression of S.L.F. + kg P/SU for North or South Islands = .86

Major soil groups 1-Recent soils, 2-Rendzina soils, 3-YGE and intergrades 4-YBPU and volcanic intergrades, 5-YBSANDS and volcanic intergrades, 6-YBE-N & Central, 7-YBL and intergrades, 8-Brown granular loams, 9-Brown granular clays and BRGRloams and clays, 10-Brown and red loams, 11-Gleys and organic soils, 12-Steepland soils.

3.3 Pasture utilisations of North and South Island pastures

The pasture utilisations of the North Island low and high producing areas were similar (Table 3.4), unlike the lower pasture utilisation of the low producing South Island pastures. The potential stocking rates of low producing South Island areas were considerably below that for the other soils.

When pasture utilisations of low producing areas are compared with those of high producing areas for the North Island in (Table 3.5), even that on the MWBES farm class of hard hill was not much below that on other farm classes; there does not appear to be a great difference between stocking rates at all levels between high and low producing areas.

The areas in grassland only have been used for this study, and any areas where there is scrub, bush present have not been included. North Island soils in many areas have been cleared of bush and scrub, and can have a problem of reversion if not reasonably well utilised, in contrast to many areas of the South Island such as the tussock grasslands which are in natural grasslands. It could be that the types of development or use on low producing pastures have had a major influence on the present utilisation.

Another criteria for selection of areas that should be developed could be the pasture establishment needs of a soil. Pasture establishment needs (kg P/ha) are dependent on the P retention of the soil (which is correlated with the SLF) and the Olsen P level. Where the Olsen P levels are high and P retentions are low, as in the South Island yellow grey earths (Table 3.6) initial needs are low, and even though pasture utilisations are also low, the amount of P/su is also low. However, efficiency of P use could be judged from a viewpoint of efficiency compared to the maximum efficiency for a soil or groups of soils. The amounts of P needed per stock unit on yellow grey earths in Table 3.6 are low even though the pasture utilisations are low. Increasing pasture utilisation to that of the top farmer on that soil group has only slightly increased the use of P/su (Table 3.6) and a further increase in utilisation to the potential stocking rate of 90% pasture utilisation, and 95% relative yield increases the kg P/su to a value which is still less than that for some of the North Island soils at average farmer stocking rates (Table 3.3). Even at the potential farmer stocking rate the maximum rate of P/ha for Marlborough high country

yellow grey earths would be 15.6 kg P/ha (195 kg super/ha), while that for a North Island soil, e.g. for low producing yellow brown loams and intergrades, at average farmer stocking rates would be the same (15.8 kg/ha). The rate per su would be considerably higher for the yellow brown loams (1.61 kg P/su, Table 3.3, vs 0.90, table 3.6 for the Marlborough high country yellow grey earths.

Table 3.4 : S.RATES AND PASTURE UTILISATION OF NORTH AND SOUTH ISLANDS COMPARED

	Average su/ha.	Top su/ha.	Pot. su/ha.	Pasture utilisation (average)
S.I. low prod. areas	2.51	4.00	5.60	47
S.I. high prod. areas	9.70	10.78	18.17	65
NI low prod. areas	8.7	11.6	14.2	65.1
NI high prod. areas	12.1	16.4	20.2	65.4

Table 3.5 : NORTH ISLAND, PASTURE UTILISATIONS AND STOCKING RATES OF MEAT AND WOOL BOARD ECONOMIC FARM CLASSES.

	Pasture utilisation low prod.	Pasture utilisation high prod.	Average su/ha. low prod.	Average su/ha. high prod.
Hard Hill	64	69	6.9	7.9
Easier Hill	66	68	9.3	9.9
Intensive finishing	64	64	11.4	13.2

	Top su/ha. low prod.	Top su/ha. high prod.	Potential su/ha. low prod.	Potential su/ha. high prod.
Hard Hill	9.0	10.0	11.1	11.8
Easier Hill	12.6	13.3	15.1	15.6
Intensive finishing	14.9	18.0	19.2	22.5

	Pasture utilisation top low prod.	Pasture utilisation top high prod.
Hard Hill	76.9	80.7
Easier	80.1	81.1
Intensive Finishing	76.9	78.6

Table 3.6: Pasture utilisation, stocking rates, pasture establishment P (kg/ha) and kg P/su for low prod. high country yellow grey earths of the South Island at average, top and potential farmer stocking rates.

(a) Average stocking rate

	Pasture utilisation low prod. area	Average rate su/ha.	Potential rate su/ha.	Pasture establish kg P/ha.	Kg P/SU (low prod.)
Canterbury	37.6	1.5	3.7	3.2	.92
Marlborough	43.4	4.5	12.0	5.0	.90
Otago	46.0	2.1	5.1	2.8	.84
Southland	36.7	2.0	6.9	7.5	1.26

(b) Top stocking rate

	Pasture utilisation	Top S.R. su.ha.	Pots. R. su/ha.	Pasture establish Kg P/ha.	Kg P/su (low prod.)
Canterbury	50.4	2.4	3.7	3.2	.91
Marlborough	68.7	7.8	12.0	5.0	.93
Otago	67.6	3.5	5.1	2.8	.86
Southland	36.7	2.0	6.9	7.5	1.25

(c) Potential stocking rate

					Kg P/su
Canterbury	90	-	3.7	3.2	1.2
Marlborough	90	-	12.0	5.0	1.3
Otago	90	-	5.1	2.8	1.2
Southland	90	-	6.9	7.5	1.6

3.4 Summary

Soils which have low soil P loss factors need less P per stock unit than soils with higher soil P loss factors. Even at the 90% pasture utilisation and potential stocking rates on some soils with low soil loss factors the inputs of P/su needed are less than those at average stocking rate where S.L.F's are higher. However, at low pasture utilisations on some South Island low producing areas, inputs of P/su are higher than would be expected, and alternatives such as increasing pasture utilisation should be the option chosen. The relationship of pasture utilisation and kg P/su with stocking rates held constant shows that increasing pasture utilisation can substitute for P fertiliser use. Relative yield increase (and use of more fertiliser) is needed to increase stocking rates once good pasture utilisation is achieved.

4. Phosphorus use and requirements compared

Phosphorus needs for New Zealand soils were calculated using the methods given in Chapter 1. P requirements for MWBES farm classes, major soil classes, and provinces are given in Appendices 1-56. First year P requirements have been calculated for low producing grasslands for both North and South Islands, but first year P needs for high producing grasslands could only be calculated for the South Island, since soil Olsen P levels were not available for improved soils in the North Island. It was not possible to determine which low producing soils were undeveloped and therefore pasture establishment P was calculated for all soils with low producing pastures for both the North and South Islands.

Summaries of these P requirements for MWBES farm classes and provinces are compared with P use in this chapter. Major soil groups were compared in Chapter 2 for P requirements, but comparisons of P requirements with P use for major soil groups were not possible since P use for major soil groups was not available. Since the MWD stock data (Table 1.11) was for 1981 the comparison is mostly with the N.Z. Meat and Wool Board Economic Service farm classes data for 1980-81 and the data from the Statistics department for the year ending June 1981. A time series set of data on the MWBES farm classes (kg P/su) from 1969-70 to the present is also compared with 1981 needs.

4.1 Phosphorus use and needs in provinces

There were some difficulties in estimating the amount of total fertiliser P applied that was used for pasture development since the area of unimproved soils that are developed each year is not directly known. The area of new grassland established in 1980/81 was estimated from the percentage effective area oversown in 1980/81 (Table 4.1) Although not all oversown land in 1980/81 would have been new development the oversown area would indicate a maximum figure for development. The area of new land development in the S.I. high country of 0.73% of effective area (Kerr et al. 1984) also corresponds closely with 0.7% from the Meat and Wool Boards sheep and beef farm survey supplement and these values are used for the SI high country.

The fertiliser P applied for maintenance during 1981 is compared with first year and long-term P needs in Table 4.2 (these P needs are shown in

Appendices 1, 2, 43, 48) for average and top farmer stocking rates for provinces in the North and South Islands). These needs do not include any pasture establishment needs for undeveloped soils. The amount of fertiliser P applied in 1981 for all N.Z. (131 million kg) was intermediate between the 107 m kg needed for high producing only (long-term) and the 146-148 kg needed for low and high producing annual total P maintenance needs. All high producing pastures would not be topdressed with P fertilisers each year. Long term maintenance needs at average farmer stocking rates for South Island soils were the same as applied P for maintenance (44 m kg) but North Island needs were 102 m kg while North Island use was 87 m kg (Table 4.2). It was suggested in the previous section that some of the North Island low producing soils (where no high producing pasture is present) would have been receiving P fertilisers as relative yields of high producing were not much different from those on the low producing level.

The proportions of total area present as high producing and the area fertilised in 1981 are shown in Table 4.3. The percentage of total area fertilised in 1981 was less than the % of high producing pastures for all provinces except Marlborough and Hawkes Bay. A larger percentage of the North Island is fertilised each year than the South Island (44 and 29% respectively) and there is an 11-12% difference between the high producing and fertilised proportions for both North and South Islands. In some provinces, both the area fertilised and high producing pasture is low (discussed later with MWBES farm classes). Returning to Table 4.2, the differences between first year and long-term P needs for all soils are five million kg more needed for long-term in the South Island at average farmer stocking rates. First year data is not available for high producing North Island soils, but 8 m kg more was needed for first year North Island soils when first year for low producing was included.

The limited data available on Olsen P levels for North Island unimproved soils suggested soil P levels were low, accounting for expected higher first year P needs for low producing pastures than for long-term (it was also noted earlier that these lower Olsen P levels were in an inverse relationship with higher P retentions in the North Island).

Maintenance phosphorus needs for top farmer stocking rates are almost double those for average farmer stocking rates (and double the present applied P Table 4.1). If pastoral production in N.Z. ever developed to the

level where top farmer stocking rates were being achieved then the amounts shown in Table 4.2 would need to be applied to sustain the required relative yields.

4.2 Phosphorus use and needs in MWBES farm classes

A comparison of MWBES (Meat and Wool Board Economic Service) survey data for 1980-81 on applied P fertiliser is shown with data from the Statistics department in Tables 4.4a and 4.4b. The amount of P used in each MWBES farm class in each province is calculated from the MWBES rate of P (kg P/ha) and the areas produced in this study. The data from the Statistics department includes all areas such as those used for dairying, horticulture and cropland whereas MWBES data excludes some small farms and the above more intensive uses. There is closer agreement between the two sets of data for the North Island than for the South Island. In the South Island applied P (Statistics department) was considerably more (45 m kg, Table 4.2) than that from the MWBES farm survey (25 m kg, Table 4.4b) using rates of P (MWBES kg P/ha) with areas of MWBES classes derived from the present study. However, using MWBES effective areas for the South Island there is closer agreement (37 m kg).

North Island intensive finishing farms had 11 m kg P applied (MWBES rates x MWBES effective areas) where more intensively used land in the North Island needs 60 m kg; the difference in areas was caused by inclusion of all farm land including the intensive uses in the P study areas.

These differences in areas are shown in Table 4.5, where there are over 3 m ha for North Island intensive finishing farms in the present study, but less than 1 m ha in the MWBES survey. Fertiliser P use for North Island intensive finishing farms (MWBES rates and P study areas) of 43.7 m kg is less than the 60 m kg needed (Tables 4.4a, 4.6). When P use in MWBES farm classes in North Island provinces is compared with P needs (Appendices 45, 46, 47) the largest difference is in the Auckland/Bay of Plenty provinces where 18 m kg was applied but 28 m kg was needed. Since the P use and P needs (Table 4a) were derived from the same areas the difference results from higher P rates needed (mainly in Bay of Plenty of 21.7 kg P/ha for high producing and 18.9 kg P/ha for low producing) than are being applied. Bay of Plenty includes about half the North Island dairy cattle (Table 1.11) and these have been classed as North Island intensive finishing farms in this study. The MWBES rate (kg P/ha) in Table 4.4a did not include

dairying; the difference can also be seen in the totals for Bay of Plenty (26.4 m kg and 34.0 m kg, Table 4a) between statistics dept data and the expected MWBES total. The total use of P in 1981 for North Island intensive finishing may be near 50 m kg (rather than 43.7 m kg).

A comparison of the percentage area fertilised with the percentage of high producing pastures of MWBES farm classes is shown in Table 4.5. The 40% of N.Z. area fertilised (MWBES survey data) is almost the same as that already obtained for totals from provinces from statistics department data (41%, Table 4.3). The lower total areas from the present P study for the more intensive farm classes of the South Island compared with MWBES areas accounts for lower amounts of P fertiliser applied in Otago and Southland (Table 4.4). Hill and high country areas of the South Island from the P study and the MWBES survey are similar (Table 4.5). P use (9.5 m kg) on North Island hard hill farms (using MWBES rates for 1980-81 and P study areas) is similar to the long-term needs (Table 4.4) but the amount applied in 1980-81 (MWBES rates x MWBES effective areas) is more than long-term needs; this is caused by differences in areas (Table 4.5 for North Island hard hill farms). Most of the large differences between long-term maintenance P needs and use of P in 1980-81 for hill and high country of the South Island (Table 4.4a) are caused by higher rates of P needed than are currently being applied, as areas are comparable (Table 4.5). These higher rates will be discussed later in connection with rates of P used per stock unit.

A comparison is made in Table 4.6 of P maintenance needs and P use for the MWBES farm classes at average and top farmer stocking rates. South Island hill and high country and finishing breeding farms in 1980-81 (all soils) were receiving less than their long-term needs of P at average farmer stocking rates. However the amount applied would almost meet long-term maintenance needs for high producing pastures only. Mainly high producing pastures in the South Island hill and high country would have been receiving fertiliser P: pasture relative yields for high producing pastures in these farm classes were higher than for low producing pastures (see section 2.3) and the area fertilised was considerably less than the area of high producing pastures (Table 4.5). North Island soils in 1980-81 received adequate amounts of P for long-term (or first year) requirements when only maintenance was considered at average farmer stocking rates for all the soils. This would explain the high relative yields of both high producing and low producing areas as described in the previous sections.

At the top farmer stocking rates the MWBES farm classes would need about double the present amount that is being applied (long-term maintenance only) with greater increases needed for the South Island hill and high country. These increases are similar to those shown in Table 4.2 for provinces.

There must be a considerable amount of P applied to low producing areas of the North Island hard hill farms as 58.1% of the total area was fertilised in 1980-81 but only 11.9% was classed as high producing pastures (Table 4.5). The greatest needs for P for North Island hard hill farms were in Wellington (Table 4.4) followed by Auckland/Bay of Plenty and Taranaki. Wellington hard hill had 56% of the total fertiliser P applied on hard hill farms in 1980-81 in the North Island.

Steepland soils on hard hill farms in the Wellington province need about 2.2 m kg P for maintenance (about 40% of Wellington hard hill needs, Fig 4.1) mostly for the low producing soils. High producing pastures form only 5.8% of the hard hill area in Wellington province. Grassland oversown (and therefore the maximum area established) in the Wellington province was more than in the other provinces (30,451 ha, Table 4.1); much of this would have been steepland as steepland soils form 36.2% of all low producing pastures on Wellington soils (all farm classes).

Steepland soils and yellow brown loams and intergrades in Taranaki are the main soils needing P fertilisers on hard hill farms (Fig 4.2, mostly low producing pastures). Hard hill soils with low producing pastures in Taranaki form 57.4% of all low producing pastures in Taranaki, with 31.5% steepland and 19.5% yellow brown loams and intergrades.

Table 4.1 Method for calculation of P (kg) applied in N.Z. for maintenance during year ended 30 June 1981 from the total P applied (Statistics Dept.), MWBES % of effective area of farm classes oversown and predicted rate of application of pasture establishment P (from P needs, kg P/ha for undeveloped soils).

	Total areas in MWBES farm classes* NI Hard Hill	NI Hill	NI Int. Fin	% of effective oversown** in 1981	Total effective area (from Table 2.1)	area ha oversown	Pasture estab. rate of P kg P/ha needed (from P study)	Pasture establs. P (kg P) applied* year ended 1981 (area x rate)	Stats. dept P applied in year ended 30.6.81 (kg P)	Estimated P applied (kg P) for maint. only (yr end 1981)	% of P applied used for pasture estab. yr end 1981
Northland	18,743	454,996	271,528	1.00	745,000	7,450	39.21	292,115	12,572,000	12,279,885	2.3
Auckland and	14,889	119,043	219,531	1.12	353,000	3,954	21.98	86,909	5,512,000	5,425,091	1.6
Bay of Plenty	113,904	442,164	1,114,006	1.18	1,679,000	20,025	66.51	1,331,863	30,819,000	29,487,137	5.1
East Coast	73,525	400,286	249,815	1.27	724,000	9,195	28.27	259,943	5,107,000	4,847,057	5.1
Hawkes Bay	58,066	341,478	473,885	1.18	874,000	10,313	21.91	225,958	12,429,000	12,203,042	1.8
Taranaki	120,224	143,440	265,480	1.61	529,000	8,517	56.06	477,463	7,371,000	6,893,537	6.5
Wellington	518,404	476,823	650,170	1.85	1,646,000	30,451	30.64	933,019	18,305,000	17,371,981	5.1
North Island	917,755	2,378,230	3,271,415	1.38	6,567,000	89,904	38.69	3,607,268	92,115,000	88,507,730	3.9
	SI High C.	SI Hill C.	SI Fin Breed								
Marlborough	231,053	102,591	77,689	1.42	435,000	6,177	13.05	80,609	2,459,000	2,378,391	3.3
Nelson	50,072	42,892	81,104	1.31	210,000	2,751	19.07	52,462	2,786,000	2,733,538	1.9
Westland	36,337	9,715	42,132	0.98	106,000	1,039	9.51	9,881	1,631,000	1,621,119	0.6
Canterbury	1,309,081	597,824	648,636	1.40	2,701,000	37,814	12.31	465,490	13,999,000	13,533,510	3.3
Otago	1,650,081	536,525	375,461	1.33	2,642,000	35,139	13.42	471,565	11,922,000	11,450,435	4.0
Southland	306,013	213,957	424,628	1.22	1,174,000	14,323	31.05	444,729	14,235,000	13,790,271	3.1
South Island	3,582,637	1,503,504	1,649,650	1.34	7,265,000	97,242	14.69	1,524,737	47,032,000	45,507,264	3.2
New Zealand					13,832,000			5,132,005	139,147,000	134,014,994	3.69

* N.I. areas from Appendix 57 and S.I. areas from Appendix 42

** % of effective area oversown in 1980/81 (and therefore maximum developed area in provinces) weighted for area of each MWBES farm class (37% for N.I. hard hill, S.I. hill, 1.0 for N.I. hill, N.I. Int. Fin., S.I. Int. Fin. 0.7 for S.I. High C., from MWBES supplement to Sheep and Beef Farm Survey)

Table 4.2: Comparison of predicted P needs (kg P) from P study for annual maintenance at average and top farmer stocking rates with P applied for maintenance*(from table 4.1 of 1981 data, Statistics dept.).

Provinces	Statistics dept. data from Table 4.1a	Average S.R., 1st yr low p. long term high p.	Top S. Rate 1st yr low p. long term high p.	Average S.R. 1st yr high p. (S.I. only)	Average S.R. long term high p. only	Average S.R. long term high p.+ low p.	Top S. Rate long term high p.+ low p.
Northland	12,279,885	10,662,573	17,612,853	-	9,704,134	10,365,350	16,932,561
Auckland + Bay of Plenty	5,425,091 29,487,137	42,303,133	62,384,956	-	31,484,278	38,484,798	55,696,322
East Coast	4,847,057	8,400,179	12,245,759	-	5,995,461	7,802,649	10,855,000
Hawkes Bay	12,203,042	12,377,643	21,914,804	-	7,672,092	11,736,776	18,189,849
Taranaki	6,893,537	10,967,058	16,990,983	-	7,958,457	10,562,663	15,072,546
Wellington	17,371,981	24,647,420	42,078,397	-	12,204,761	22,729,611	33,879,302
North Island	88,507,730	109,358,012	173,227,755	-	75,019,186	101,681,848	150,625,582
Marlborough	2,378,391	1,493,784	3,569,363	153,876	995,785	2,050,115	3,684,089
Nelson	2,733,538	2,065,578	3,846,276	513,471	1,574,616	2,276,693	3,700,340
Westland	1,621,119	1,133,191	2,339,048	209,587	931,067	1,526,232	2,547,289
Canterbury	13,533,510	12,602,435	22,290,839	2,854,745	11,408,164	14,408,036	22,704,089
Otago	11,450,435	7,895,408	13,943,992	1,753,564	5,803,667	10,040,267	15,085,924
Southland	13,790,271	13,625,617	19,539,452	3,518,197	11,225,406	13,581,493	18,478,358
South Island	45,507,264	38,816,013	65,528,970	9,003,440	31,938,705	43,882,836	66,200,089
New Zealand	134,014,994	148,174,025	238,756,725		106,957,891	145,564,684	216,825,671

* assuming all low producing pastures need first year or long term maintenance without allowing for pasture establishment needs on undeveloped soils, which could be higher than first year needs on some of these soils.

Table 4.3: Areas topdressed (ha) with phosphatic fertilisers (Statistics dept. , 1981) compared with areas of high and low producing total area of grassland used in study and % of area fertilised in 1981.

Provinces	Stats. dept. in year ending 30.6.81 (ha)	High p. area (ha) in study	Total area (ha) of high p. + low p.	% of area fertilised in 1981	% of area that is high prod.
Northland	404,428	693,855	745,267	54	93
Auckland + Bay of Plenty	1,390,345	1,592,368	2,050,537	68	78
East Coast	278,265	516,870	723,626	38	71
Hawkes Bay	545,092	524,775	873,429	62	60
Taranaki	284,210	330,341	529,144	54	62
Wellington	703,151	707,866	1,645,397	43	43
North Island	3,605,491	4,366,075	6,567,400	55	66
Marlborough	139,717	111,778	431,900	32	26
Nelson	103,687	118,772	209,952	49	57
Westland	46,611	61,522	105,480	44	58
Canterbury	677,592	1,248,249	2,701,606	25	46
Otago	582,922	662,198	2,641,938	22	25
Southland	574,124	785,728	1,173,953	49	67
South Island	2,124,653	2,988,247	7,264,829	29	41
New Zealand	5,730,144	7,354,322	13,832,229	41	53

Table 4.4a: Fertiliser P (kg P) applied in the South Island in 1981 calculated by MWBES estimates of kg P/ha multipled by area (P study area) compared with the amount applied in 1980-81 (Statistics dept.) and predicted long term needs.

Provinces	South Is. high country	South Is. hill country	South Is. fin. breed.	South Is. Intens. finishing	South Is. mixed crop + finishing	Province totals from MWBES rates + P study areas	Province totals (Stats dept, from Table 4.1)
Marlborough	129,390	380,613	630,835	242,382	29,534	1,412,754	2,377,000
Nelson	28,040	159,129	658,564	126,123	53,684	1,025,540	2,739,000
Westland	20,349	36,043	342,112	3,678	-	402,182	1,621,000
Canterbury	733,085	2,217,927	5,266,924	1,713,404	92,942	10,024,282	13,570,000
Otago	924,045	1,990,508	3,048,743	386,580	1,790	6,351,666	11,496,000
Southland	171,367	793,780	3,447,979	1,707,356	-	6,120,482	13,907,000
South Island	2,006,276	5,578,000	13,395,157	4,179,523	177,950	25,336,906	45,710,000
MWBES rates 1980-81 (kg P/ha x effective area** see Table 4.5)	1,760,640	6,103,692	11,818,660	12,188,799	5,285,952	37,157,743	
P reqts, long term high + low producing average f. stock rate	8,446,221	10,009,820	19,749,911	3,905,469	170,300		

* Fertiliser usage 1980-81, Supplement to the Sheep and Beef Farm Survey, NZMWBES.

** Totals include only sheep and cattle areas.

*** Totals include high producing areas used for dairying, horticulture and cropping in P study areas.

Table 4.4b: Fertiliser P (kg P) applied in the North Island in 1981 calculated by MWBES estimates of kg P/ha multiplied by area (P study area) compared with the amount applied in 1980-81 (Statistics dept.) and predicted long term needs. for maintenance.

Provinces	North Is. Hard hill	North Is. Easier hill	**Intensive finishing North Is.	Province totals from MWBES rates and P study areas	Province totals (Stats. dept., from Table 4.1)
Northland	194,177	5,573,701	3,630,330	9,398,208	12,572,000
Auckland + Bay of Plenty	1,334,295	6,874,786	18,190,380	26,399,461	34,479,000
East Coast	761,719	4,903,504	3,340,027	9,005,250	4,749,000
Hawkes Bay	601,564	4,183,106	6,335,842	11,120,512	12,159,000
Taranaki	1,245,521	1,757,140	3,549,468	6,552,129	6,618,000
Wellington	5,370,665	5,841,082	8,692,773	19,904,520	17,090,000
North Island	9,507,942	29,133,318	43,738,819	82,380,080	87,254,000
MWBES rates 1980-81 (kg P/ha x effective area*** see Table 4.5)	14,036,764	22,553,475	11,118,492	47,708,731	
P reqts, long term high and low producing average f. stock rate	8,980,832	31,925,475	60,775,541		

* Fertiliser usage 1980-81, Supplement to the Sheep and Beef Farm Survey, NZMWBES.

** Includes high producing areas used for dairying, horticulture and cropping in P study areas.

*** Totals include only sheep and cattle areas.

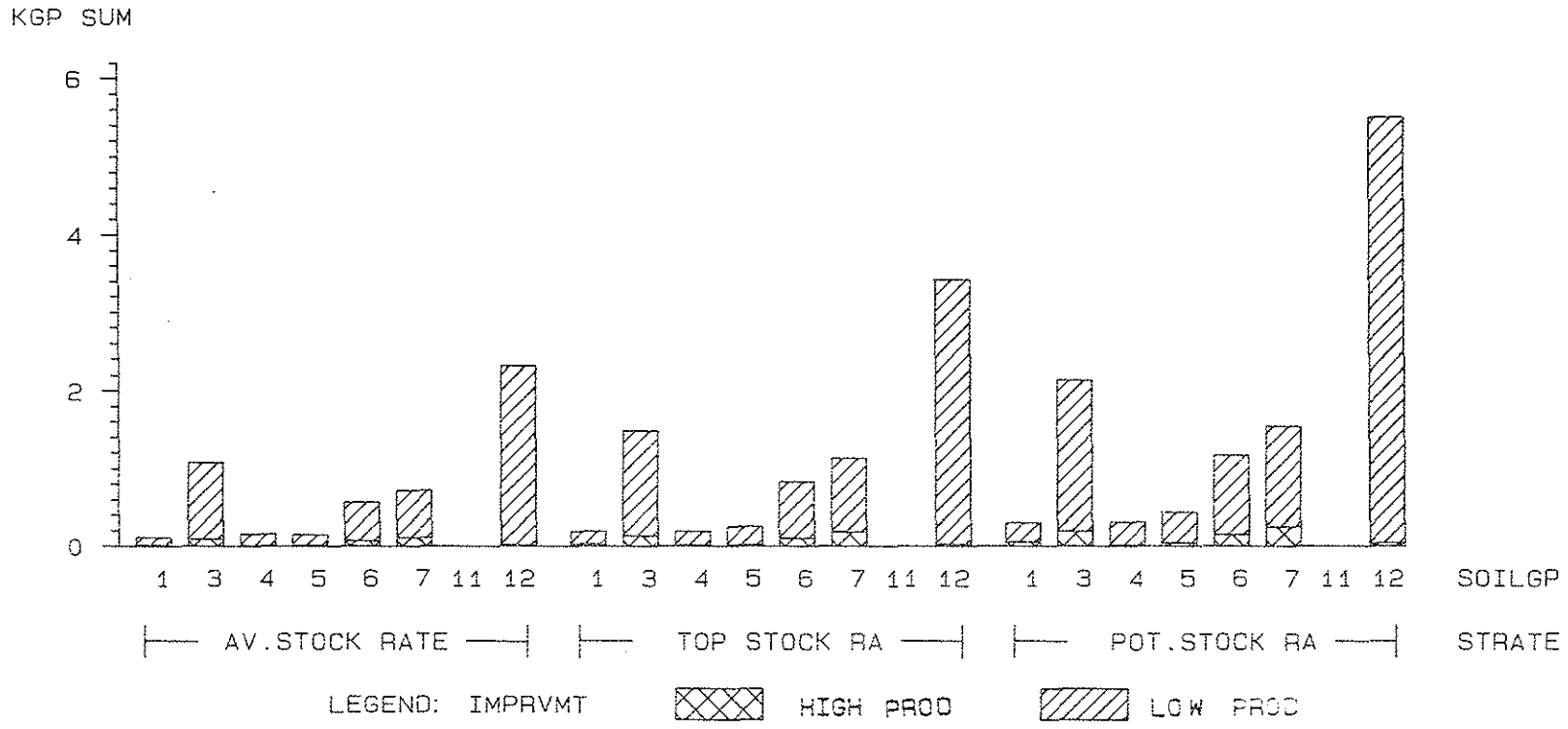
Table 4.5: Areas of each farm class used in P study compared with areas obtained from N.Z. Meat and Wool Board Economic Service Survey and % area fertilised with phosphatic fertilisers in 1980-81 (MWBES) compared with % high producing pasture areas.

	*MWBES 1980-81 effective hectares	MWBES 1980-81 total hectares	Total area** used in P study	% area fertilised pasture + crop MWBES 1980-81	High produ area as % of total area
S.I. high country	3,144,000	3,144,000	3,582,637	4.3	12.6
S.I. hill country	1,645,200	1,736,100	1,503,504	27.5	48.5
N.I. hard hill	1,140,700	1,354,900	917,755	58.1	11.9
N.I. easier hill country	1,841,100	2,029,800	2,378,230	63.4	54.0
N.I. intensive finishing	831,600	884,400	3,271,415	66.7	90.9
S.I. finishing breeding	1,455,500	1,467,800	1,649,650	53.0	90.6
S.I. intensive finishing	699,300	721,500	239,789	67.2	95.6
S.I. mixed cropping + finishing	410,400	410,400	13,816	71.5	100.0
all classes	11,770,000	11,176,000	13,556,796	40.4	53.7

* Sheep farms only (less waste areas)

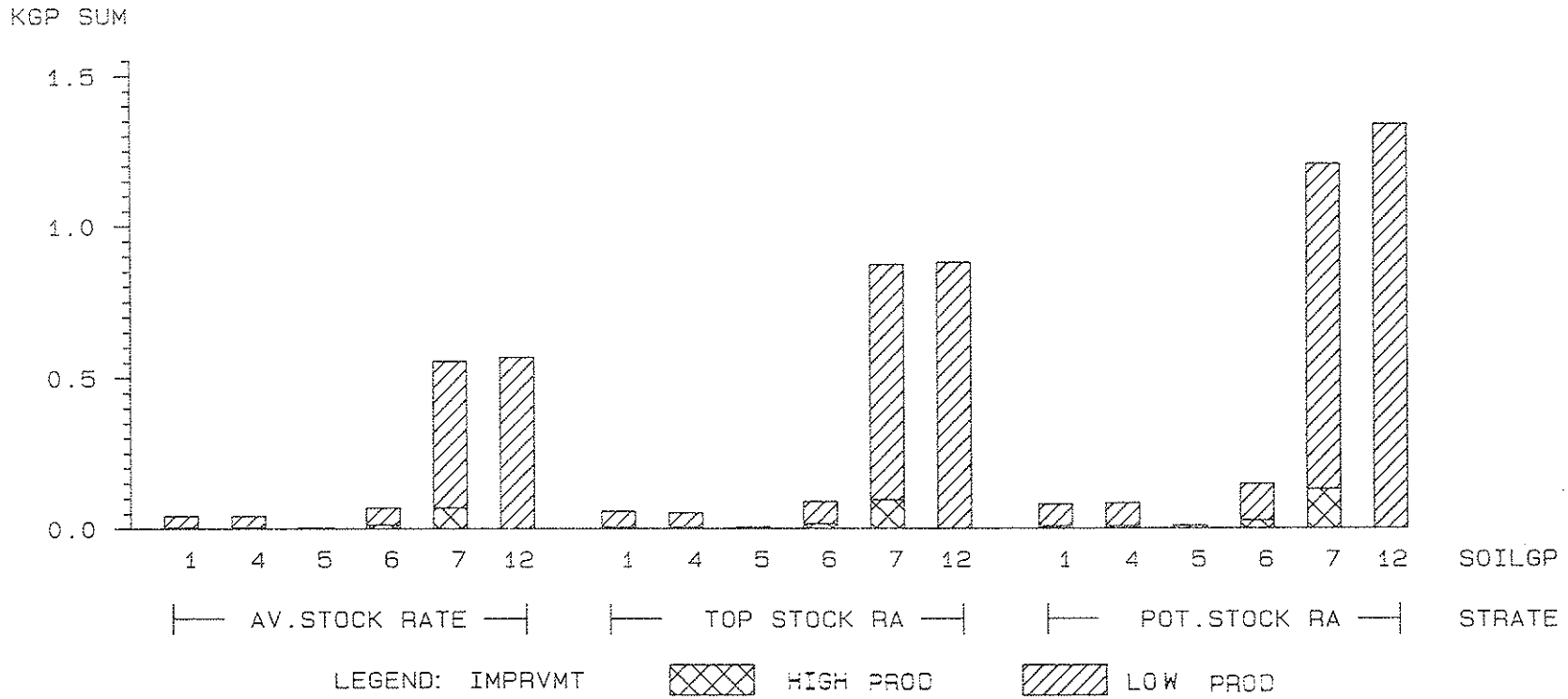
** Includes dairying, cropping, horticulture treated as pastoral grazing land, that are fertilised for stocking rates.

FIG. 4.1 P MAINTENANCE NEEDS (million kg) OF
HARD HILL COUNTRY OF WELLINGTON PROVINCE OF THE NORTH ISLAND,
FOR MAJOR SOIL GROUPS, LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

FIG. 4.2 P MAINTENANCE NEEDS (million kg) OF
HARD HILL COUNTRY OF TARANAKI PROVINCE OF THE NORTH ISLAND,
FOR MAJOR SOIL GROUPS, LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

4.3 P per stock unit for MWBES farm classes

P requirements for the MWBES farm classes (Table 4.6) did not include allowances for pasture establishment during 1981. Undeveloped soils needing pasture establishment P have maintenance applied after 1-3 yrs depending on the stock carrying capacity (Section 1.3). The amount of P needed for North and South Islands for pasture establishment was calculated in Table 4.1 for provinces, from MWBES data on oversown areas and Kerr et al., (1984) provide data also for the South Island high country. These allowances for pasture establishment are added to maintenance requirements in a comparison of MWBES data of kg P/stock unit for 1980-81 and P requirements (Table 4.7). A comparison of rates of P per stock unit avoids having to classify areas into different farm classes, and is also a measure of efficiency of P use (as described in Chapter 3). Potential farmer stocking rates of all farm classes are greater than 6 s.u./ha, except for low producing S.I. high country (4.07), and first year maintenance P would therefore need to be applied in the year after the establishment P had been applied on undeveloped soils (see 1.3, pasture establishment calculations).

The current rate of P applied per stock unit for the South Island high country is much less than that needed (Table 4.7, 1.13 kg P/su needed, 0.74 kg P/su applied for low producing, high producing or all soils) and only in 1973-74 was sufficient P applied (Figure 4.3). The levels in 1985-86 and 1986-87 are forecast to be about half of the long-term needs per stock unit. Long term needs per stock unit for South Island hill country are similar to those of the high country (Table 4.7, Figure 4.3) but use of P in the South Island hill country has been more, with the amount of P fertiliser used in 1980-81 and the average for the 1969-70 to 1984-85 equal to the long-term needs at average farmer stocking rates.

North Island P requirements per stock unit are higher than those for the South Island (Table 4.7, Figures 4.3, 4.4). This was explained in 3.2 by the higher soil P losses in the North Island. The amount of P needed per stock unit closely follows the soil P loss factor in each farm class and is significantly correlated with P/stock unit in the regression

$$y(\text{kg P/su}) = .44 + 3.16\ x, \text{ where } x = \text{SLF}, r^2 = 0.93.$$

As will be shown later there is a similar linear regression for provinces. The average amount applied from 1969-70 to 1984-85 was below the long-term needs of the MWBES farm classes (Table 4.7, Figure 4.4) except for the most intensive farm classes in the South Island.

Where less P has been applied than the long-term needs, Olsen P levels in the soil will eventually decrease and relative yields (pasture production) will decrease to a lower level. Increased utilisation would have to occur or animal performance and stock numbers would show large decreases in the long-term. All farm classes have predicted fertiliser applied per stock unit in 1985-86 to 1986-87 of less then 50% of long-term needs, while North Island hard hill has about 30% predicted (Figures 4.3, 4.4, 4.5). If this level is maintained, animal product outputs will eventually drop to low levels.

4.4 P per hectare comparisons

A comparison between MWBES data (kg P/ha) and long-term P needs for the MWBES farm classes is shown in Figures 4.6, 4.7, 4.8. The long-term maintenance needs per hectare (and for establishment) for South Island hill and high country are considerably greater than the amount applied (Figure 4.6, Table 4.8). However the long-term needs for South Island hill country per stock unit were similar to the amount of fertiliser applied (Table 4.7, Fig 4.3).

The differences between per stock unit and per hectare data for the MWBES farm classes are the result of differences in stocking rates between the MWBES survey data and the P study data, as shown in Table 4.9a. Average farmer stocking rates (su/ha) on all soils in the South Island high country in the present study were three times those of the MWBES survey and those for the South Island hill country about twice. The previous comparisons using kg P per stock unit avoided these problems caused by stocking rate differences since amounts per stock unit were compared. However it appears that South Island hill and high country P needs on a per hectare or total amount of P have been overestimated for these two farm classes. Since the areas of these two farm classes were similar from both sources of data, either stocking rates derived from MWBES data or from MWD data are not realistic. Since MWBES data includes Class VIII land (which this study does not include), some of the differences would result from this inclusion. The number of stock units present in the high country at the end of 1981 was 2.5 million (MWBES survey data and Kerr and Lefever, 1984) but the stock units predicted to be present in 1981 in this study were 8.2 million. Stocking rates however for the other MWBES farm classes, particularly the North Island are comparable (Table 4.9a) and the amounts

of P and P needs per hectare for these farm classes are satisfactory for the comparisons in this study.

Average farmer stocking rates of provinces (su/hectare) are shown in Table 4.9b. Stocking rates were obtained from the MWD database. South Island provinces of Marlborough, Nelson and Westland have higher stocking rates from MWD data used for this P study compared to those from the Statistics department. This difference probably results from Statistics department data including all grassland, including class VIII. Areas of grassland (Table 1.11) showed differences between the two sets of data. The overall stocking rate for North Island provinces in the present study however were similar to those of the Statistics department. North Island provinces also were similar in the two sets of data (Table 4.9b).

Total stock units within provinces showed reasonable agreement between the two sets of data and P requirements calculated in this study for provinces were based on a satisfactory set of stock data.

Table 4.6: Comparison of predicted P needs for maintenance only (kg P x 1 million) from present study at average and top farmer stocking rates with P applied for maintenance (from Table 4.4 of 1980-81 MWBES data of kg P/ha and areas from P study).

	High country South Is.	Hill country South Is.	Hard hill North Is.	Easier hill North Is.	Intensive finishing North Is.	Finishing - breeding South Is.	Intensive finishing South Is.	Mixed crop + finishing South Is.	Totals
(kg P x 1 million) Fertiliser P use MWBES estimates (from Table 4.4) 1980-81	2.0	5.6	9.5	29.1	43.7	13.4	4.2	0.2	107.7
Maintenance only P needs from P study kg P x 1 million First yr. low prod. long term high prod. average f.s. rate	5.5	8.4	10.6	36.3	62.5	19.3	3.8	0.2	146.6
First yr. low prod. long term high prod. top f.s. rate	12.4	16.2	18.9	60.6	93.7	28.9	5.3	0.3	236.3
Average s. rate first yr high prod. (S.I. only)	0.8	1.3	-	-	-	6.1	0.6	0.09	(S.I. only) 8.89
Average s. rate long term high prod.	3.1	6.1	1.2	17.8	56.0	18.1	3.7	0.2	106.2
Average s. rate long term high prod. + low prod.	8.4	10.0	9.0	31.9	60.8	19.7	3.9	0.2	143.9
Top s. rate long term high prod. + low prod.	14.1	15.7	13.0	47.8	89.9	28.7	5.3	0.3	214.8

Table 4.7: Comparison of kg P/su from MWBES 1980-81 data with maintenance P (kg P/su) for long term P needs obtained from present P study (based on 1981 stock data).

MWBES farm classes	MWBES (a) kg fert. per su 1980-81	MWBES kg P for 1980-81 per su ((a) x 0.07)	P study long term kg P/su for low prod.	P study long term kg P/su for high prod.	P study long term kg P/su for all soils (maint.)	Pasture estab* kg P/su	P study for maint. + estab* for all soils	mean MWBES kg P/su 1968-69 to 1984-85 (from Figs 4.3,4.4,4.5)
S.I. high country	10.6	0.74	1.11	0.94	1.09	0.04	1.13	0.77
S.I. hill country	17.4	1.22	1.10	1.00	1.05	0.09	1.14	1.09
N.I. hard hill	17.2	1.20	1.34	1.41	1.35	0.17	1.52	1.25
N.I. easier hill	16.2	1.13	1.38	1.39	1.39	0.04	1.43	1.38
N.I. Inten. fin. farms	14.2	0.99	1.38	1.41	1.40	0.04	1.44	1.30
S.I. fin. breed. farms	13.2	0.92	1.15	1.10	1.15	0.01	1.16	1.10
S.I. Inten. fin. farms	18.8	1.32	1.21	1.21	1.21	-	1.21	1.50
S.I. mixed crop. fin. farms	27.0	1.89	-	0.96	.96	-	0.96	1.94
South Island**		1.01					1.14	
North Island**		1.12					1.45	

* Establishment P from note in Table 4.1 using % effective area oversown as estimate of area developed, P study rate of estab. P and total stock units for each MWBES farm class.

** Means for North and South Islands, weighted for areas, using total areas for MWBES classes 1980-81, Table 4.5.

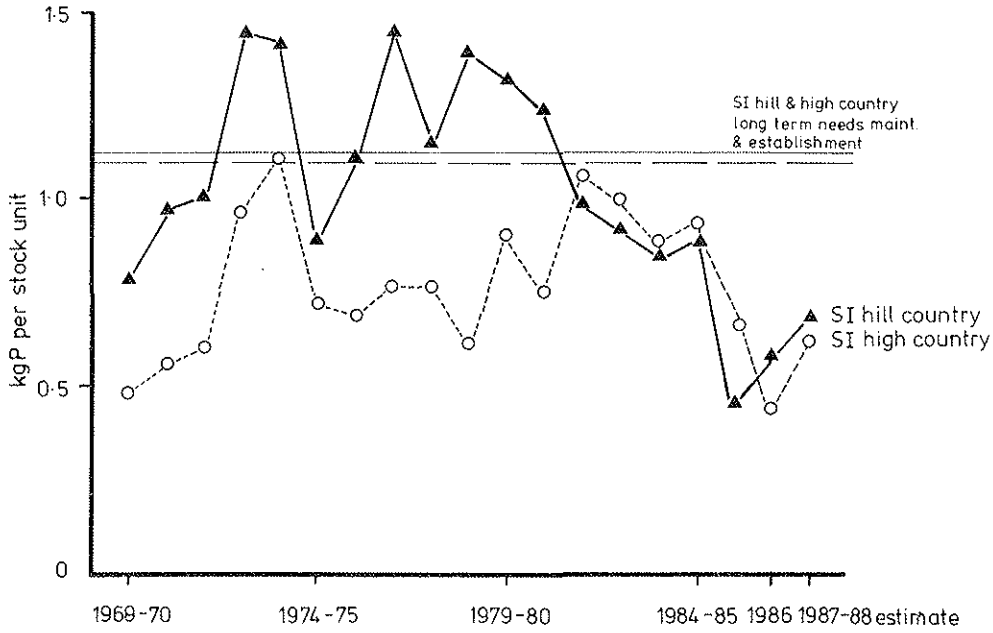


Figure 4.3: The amount of P fertiliser applied per stock unit for South Island hill and high country MWBES farm classes (kg P/su) during the 1969-70 to 1985-86 period (MWBES data), provisional amount applied during 1986-87, and estimate for 1987-88 compared with predicted needs for maintenance and pasture establishment for 1980-81.

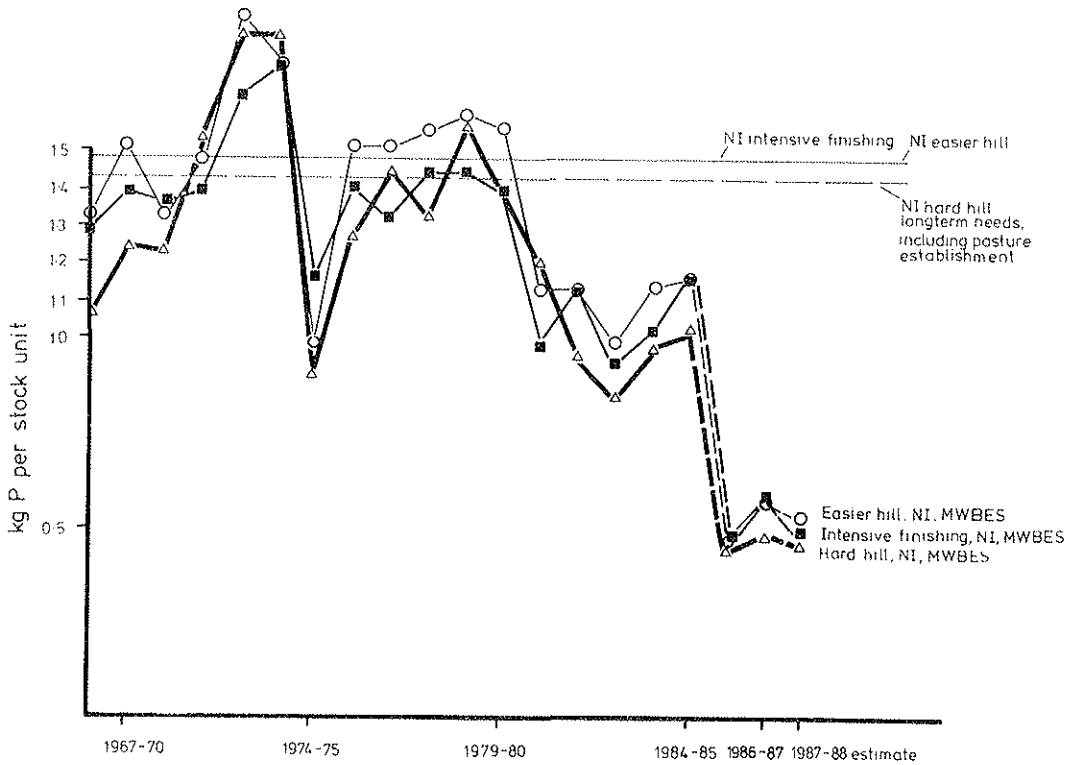


Figure 4.4: The amount of P fertiliser applied per stock unit for North Island MWBES farm classes (kg P/su) during the 1969-70 to 1985-86 period (MWBES data), provisional amount applied during 1986-87 and estimate for 1987-88 compared with predicted needs for maintenance and pasture establishment for 1980-81.

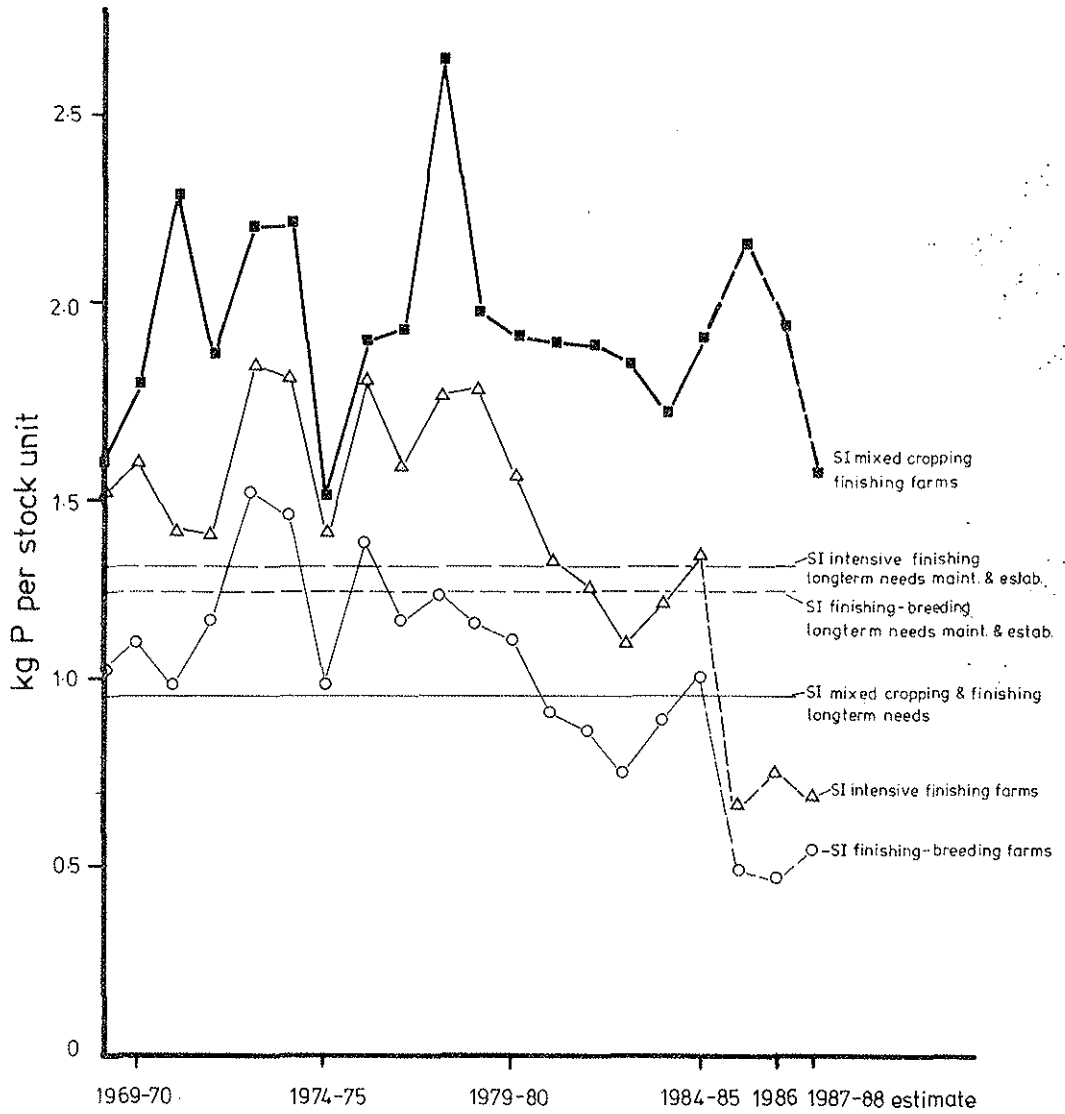


Figure 4.5: The amount of P fertiliser applied per stock unit for the more intensive South Island MWBES farm classes (kg P/su) during the 1969-70 to 1985-86 period (MWBES data) provisional amount applied during 1986-87 and estimated for 1987-88 compared with predicted needs for maintenance and pasture establishment of 1980-1981.

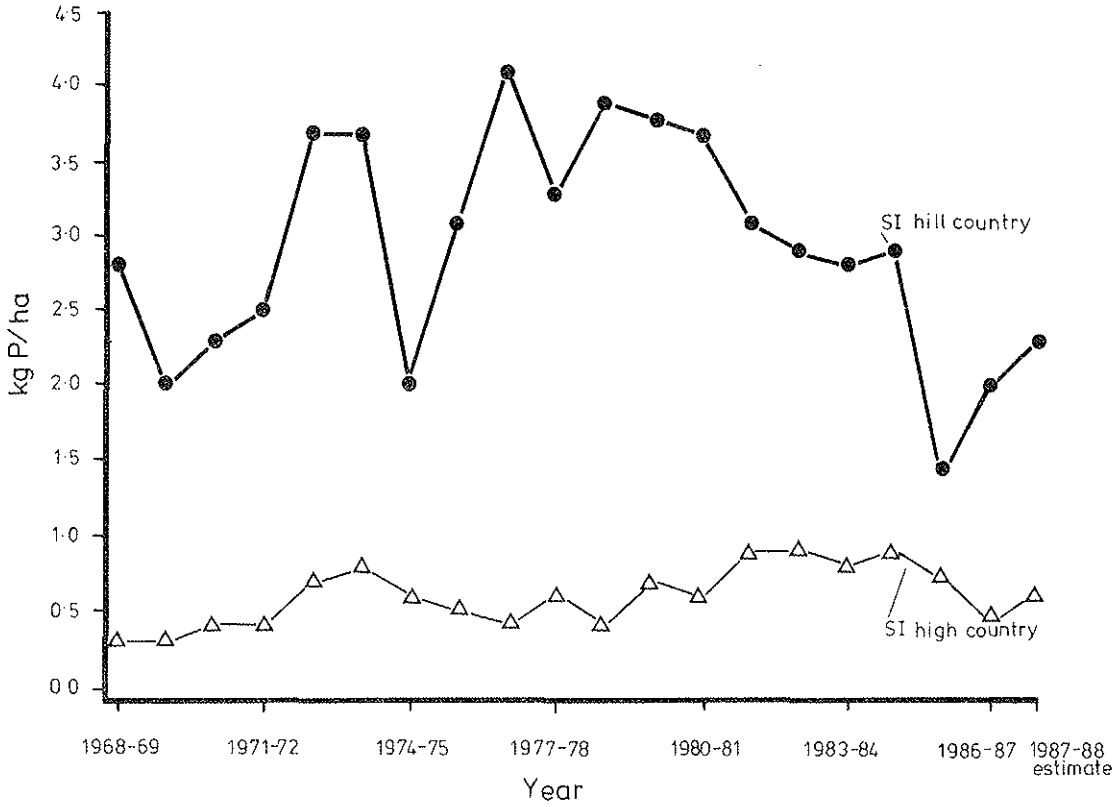


Figure 4.6: The amount of P fertiliser applied per hectare for South Island hill and high country MWBES farm classes (kg P/ha) during the 1969-70 to 1985-86 period (MWBES data) and provisional amount applied during 1986-87and estimate for 1987-88.

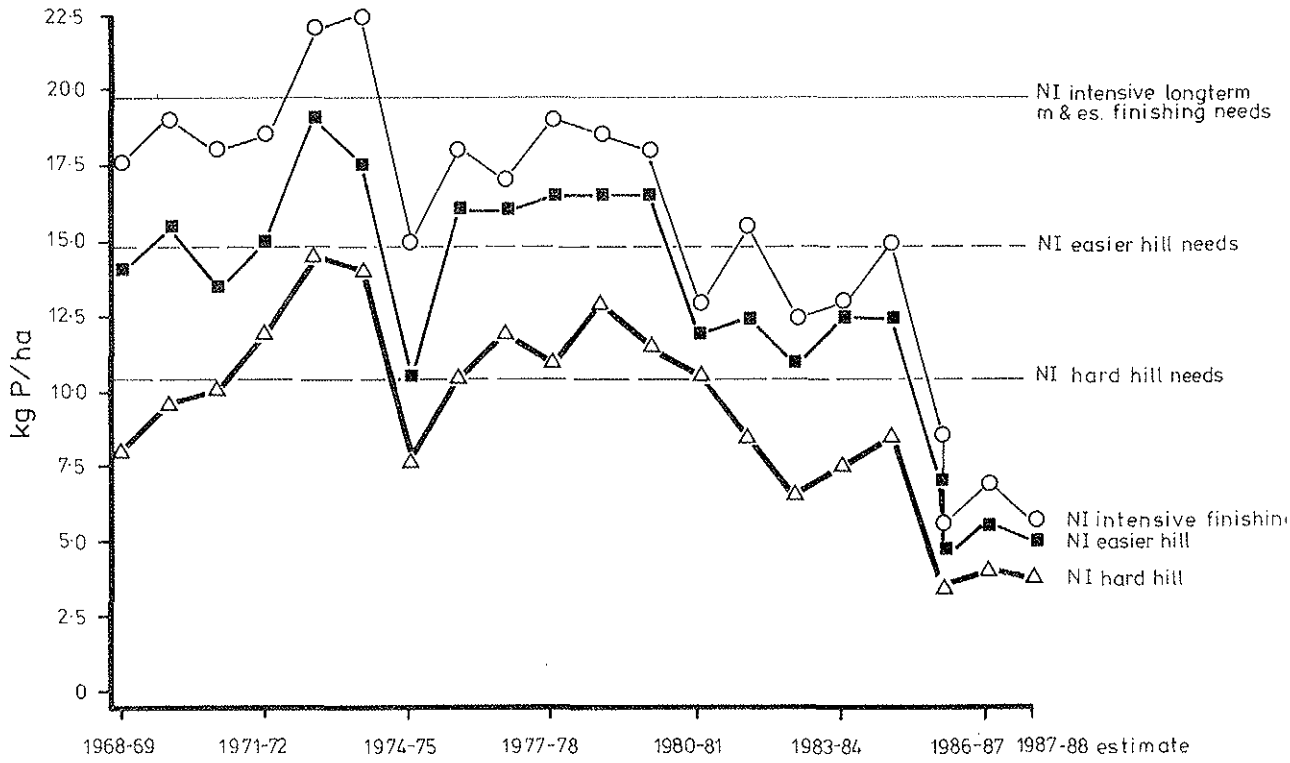


Figure 4.7: The amount of P fertiliser applied per hectare for North Island MWBES farm classes (kg P/ha) during the 1969-70 to 1985-86 period (MWBES data), provisional amount applied during 1986-87 and estimate for 1987-88 with predicted needs for maintenance and pasture establishment for 1980-81.

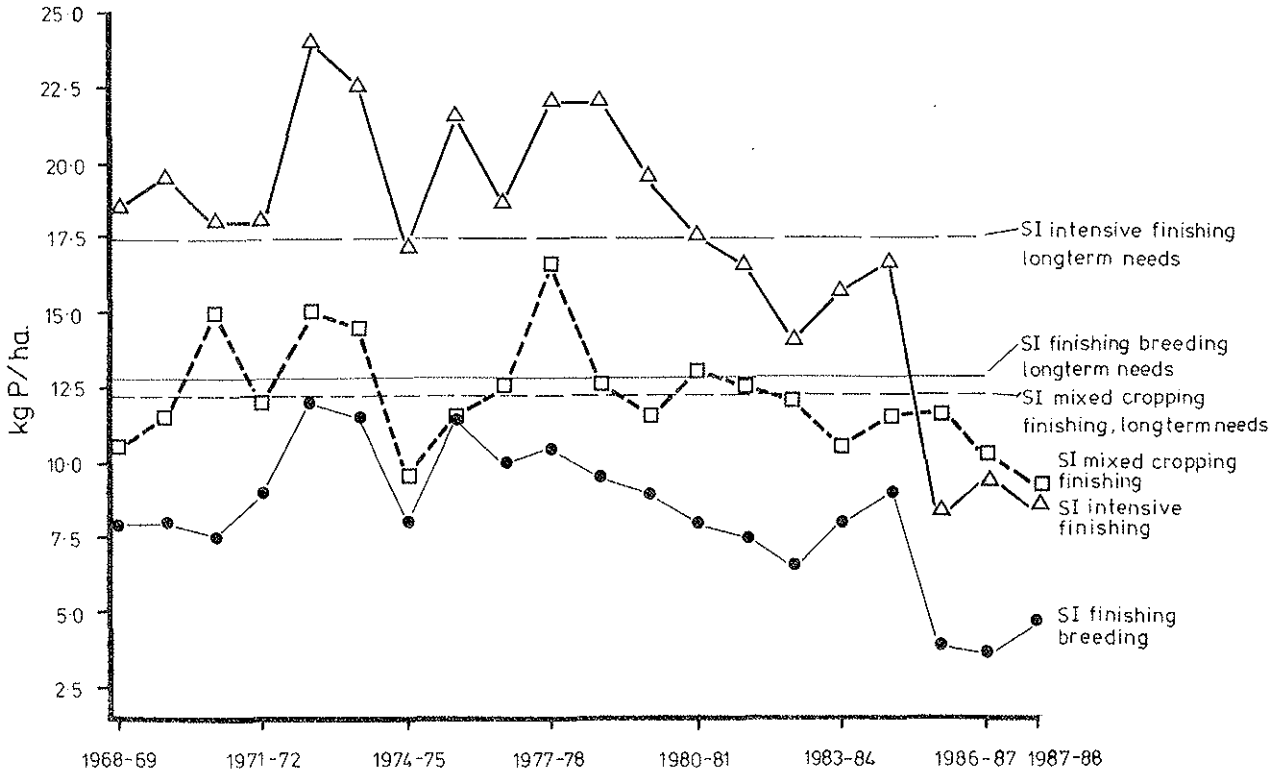


Figure 4.8: The amount of P fertiliser applied per hectare for the more intensive South Island MWBES farm classes (kg P/ha) during the 1969-70 to 1985-86 period (MWBES data), provisional amount applied during 1986-87 and estimate for 1987-88 compared with predicted needs for maintenance and pasture establishment for 1980-1981.

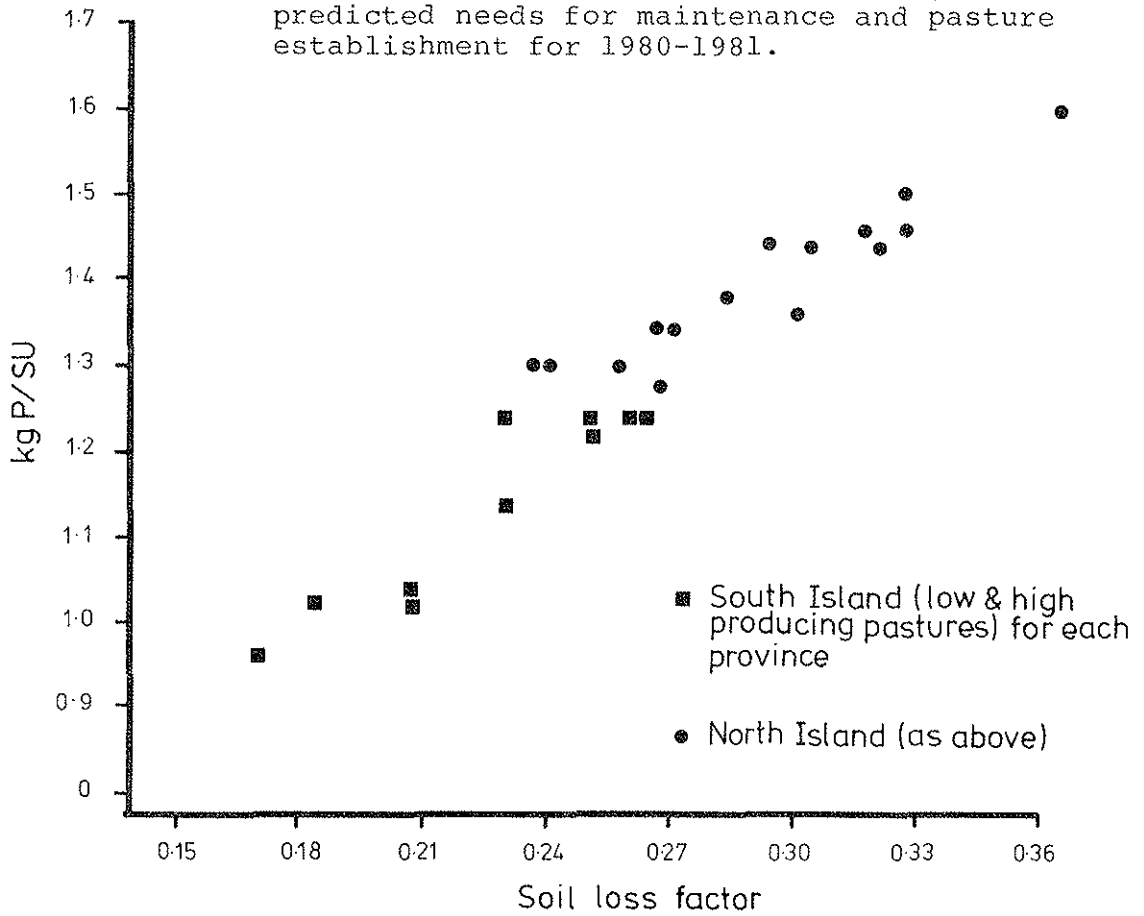


Figure 4.9: The regression of predicted needs of P per stock unit (kg P/su) for North and South Island provinces and the soil loss factors (means weighted for areas) in each province.

Table 4.8: Comparison of Meat and Wool Boards Economic Service estimates* of P rates applied in 1980-81 (kg P/ha) with predicted P needs for maintenance and pasture establishment.

MWBES farm classes	kg P/ha MWBES applied in 1980-1981 (kg fert x 0.07 includes pasture establishment)	Average farmer stocking rates, kg P/ha					long term m. + pasture estab. P for 1980-81** kg P/ha
		First year maint. for unimproved	long term maint. for unimproved	First year maint. for improved	long term maint. for improved	long term maint. for all soils	
S.I. high country	.56	.77	1.71	1.74	6.88	2.36	2.46
S.I. hill country	3.71	2.91	4.99	1.76	8.42	6.65	7.21
N.I. hard hill	10.36	11.59	9.61	not available	11.11	9.79	10.97
N.I. easier hill	12.25	16.88	12.92	"	13.84	13.43	13.83
N.I. Inten. fin. farms	13.37	21.72	15.91	"	18.85	18.60	19.11
S.I. Fin. breed. farms	8.12	7.58	10.39	4.05	12.13	11.97	12.12
S.I. Inten. fin. farms	17.43	12.29	16.33	2.69	16.29	16.28	16.28
S.I. Mixed crop. fin. farms	12.88	-	-	6.34	12.33	12.33	12.33

* New Zealand Meat and Wool Board Economic Service 1983. Supplement to the Sheep and Beef Farm Survey, 1980-81, Table A.12.

** Using North, South Island and S.I. high country pasture establishment P applied as % of total P applied from Table 4.7.

Table 4.9a: Comparison of stocking rates (su/ha) of P study, average farmer stocking rate with MWBES Survey stocking rates for MWBES farm classes.

MWBES farm classes	MWBES 1980-81 su/ha	P study average farmer stock rate		
		low pr. su/ha	high p. su/ha	all soils su/ha
S.I. high country	0.76	1.56	7.38	2.30
S.I. hill country	3.04	4.60	8.16	6.33
N.I. hard hill	8.33	6.87	7.85	6.99
N.I. easier hill	10.84	9.28	9.92	9.63
N.I. inten. fin. farms	13.50	11.43	13.26	13.10
S.I. fin. breed. farms	8.83	8.89	10.85	10.67
S.I. inten. fin. farms	13.20	13.43	13.37	13.38
S.I. mixed crop. fin. farms	6.81	-	12.76	12.77

Table 4.9b: Comparison of stocking rates (su/ha) of P study, average farmer stocking rates with stocking rates from Statistics department data (Table 2.1).

Provinces	su/ha 1981 Stats. dept	P study average farmer stock. rate low pr. su/ha	high pr. su/ha	all soils su/ha
Northland	10.21	8.93	10.34	10.24
Auckland	11.80	8.92	11.67	11.55
+ Bay of Plenty	12.25	10.47	13.71	12.86
East Coast	8.88	6.38	9.00	8.25
Hawkes Bay	10.76	8.93	11.42	10.43
Taranaki	11.51	8.84	10.34	9.78
Wellington	9.53	8.22	15.01	11.14
North Island	10.77	8.69	12.15	10.99
Marlborough	2.89	2.66	8.46	4.16
Nelson	6.19	6.14	10.83	8.79
Westland	5.07	11.16	12.40	11.88
Canterbury	5.19	1.89	9.39	5.36
Otago	3.61	2.13	8.14	3.64
Southland	8.56	4.79	11.66	9.39
South Island	4.97	2.51	9.79	5.50

4.5 P per stock unit in provinces

Comparisons of kg P per stock unit for provinces are shown in Table 4.10. The amount of P (fertiliser x 0.07) applied in the year ended 1981 in provinces and the total stock units (Table 1.11) obtained from the Statistics department for provinces were used to calculate the amount of applied P per stock unit for provinces. The South and North Island means obtained from MWBES data (Table 4.7) are lower than that of the Statistics department by 0.09 to 0.10 kg P/su. Data from more intensive uses of land have been included in results from the Statistics department, while only sheep and beef cattle farm classes have been included in the MWBES data on P use. There is a small difference between long-term total needs for the South Island (1.14 from MWBES data, 1.18 kg P/su Statistic department data). More accurate pasture establishment P needs were available for calculation of these requirements for South Island high country in the MWBES mean (Table 4.7) than were available for the total P needs calculation in Table 4.10. The amount of P applied per stock unit in 1981 for the North and South Islands respectively was 85% and 96.0% of that needed for long-term P needs in 1981 (Table 4.10). Data from MWBES farm classes in Table 4.7 showed P topdressing was 76.2 and 88.6% per stock unit of that needed for long-term for North and South Island farm classes, but only sheep and cattle areas were included in these MWBES data.

Only Northland and Auckland provinces in the North Island are receiving adequate levels of P fertiliser to meet long-term needs per stock unit. Higher rates of P are needed for the North Island because of the higher soil P losses in these provinces. A regression of kg P/su needs in the provinces of North and South Islands and soil loss factors is shown in Fig 4.9. There is a high correlation of kg P/su requirements and the soil loss factors, $r^2 = 0.916$, in the equation of

$$\text{kg P/su} = 0.426 + 3.24 \text{ SLF}$$

A similar relationship was seen between major soil groups ($r^2 = 0.86$, Table 3.7). If animal loss factors are included in the multiple regression, r^2 increases to 0.939 i.e. 96.9% of variations in P needs per stock unit between provinces are accounted for by the above two factor regression. Inclusion of the animal loss factor was significant ($p < \text{or} = 0.007$) in the equation,

$$\text{kg P/su} = .242 + 2.117 \text{ SLF} + 0.263 \text{ ALF}$$

Table 4.10: Comparison of kg P/su used during 1981 with maintenance P (kg P/su) for long term P needs for New Zealand provinces obtained from the present P study at average farmer stocking rates.

Provinces	Stats. dept (kg P x 1000) used in 1981 (from Table 4.1)	Total su x 1000 Stats. dept from Table 2.1 1980/81	Kg P/su applied in 1981 (from 2 previous columns)	P study long term M. kg P/su for low prod.	P study long term M. kg P/su for high prod.	P study long term M. kg P/su for all soils	P study for maint. + estab. for all soils*
Northland	11,882	7,372	1.61	1.45	1.35	1.36	1.39
Auckland	5,392	3,753	1.44	1.43	1.43	1.43	1.45
+ Bay of Plenty	28,661	23,615	1.21	1.43	1.50	1.48	1.56
East Coast	4,888	5,239	0.93	1.37	1.30	1.32	1.39
Hawkes Bay	11,985	10,558	1.14	1.30	1.29	1.29	1.40
Taranaki	7,021	5,412	1.30	1.46	1.59	1.54	1.64
Wellington	17,273	15,451	1.12	1.33	1.34	1.33	1.40
North Island	87,104	71,400	1.22	1.37	1.40	1.39	1.44
Marlborough	2,357	2,168	1.09	1.24	1.02	1.18	1.22
Nelson	2,631	1,813	1.45	1.24	1.22	1.23	1.25
Westland	1,604	770	2.08	1.21	1.23	1.23	1.24
Canterbury	13,006	14,876	0.87	1.14	.96	1.06	1.09
Otago	11,211	10,285	1.09	1.02	1.03	1.02	1.06
Southland	13,126	9,963	1.32	1.27	1.23	1.24	1.28
South Island	43,936	39,875	1.10	1.12	1.06	1.10	1.14
New Zealand	131,039	111,275	1.18				

* Establishment P from Table 4.1 using proportions of pasture establishment P as a % of total P applied in year ending June 1981.

The difference between North and South Islands is also evident in Table 4.7 where there was little difference between MWBES farm classes in kg P/su within the North or South Islands, but large differences between islands. Fertiliser P per stock unit applied to soils in provinces in the South Island in 1981 was closer to long-term P needs, and in some provinces if only maintenance was considered, would have been adequate (kg P/su) for high producing soils and in some provinces for low producing soils as well.

4.6 Summary

The amount of fertiliser P applied during 1981 was intermediate between the needs of high producing soils only and that needed for all high producing pastures and low producing at average farmer stocking rates. The amount of P used for pasture development from an unfertilised state in 1981 was calculated from the oversown areas during 1981 and the rate of P needed (kg P/ha) for pasture establishment. First year P needs of South Island high producing soils (5 m kg) were less than the long-term needs. First year P needs could not be determined for North Island high producing soils, but were probably at least as high as the long-term needs, as indicated by high soil P loss factors and low Olsen P levels of North Island low producing soils. A greater part of the North than South Island was topdressed with fertilisers in 1981 and there was also a greater proportion of higher producing pastures in the North than in the South Island.

If pastoral production were to increase to the level of the top farmer, then topdressing of phosphatic fertilisers would have to be double that used in 1981. Average farmer stocking rates of South Island MWBES farm classes derived from MWD data were considerably higher than those from the MWBES survey and the amounts of P needed calculated for total P or kg P/ha were too high for these farm classes. Average farmer stocking rates of North Island farm classes of the P study data and the MWBES were similar and needs for P of total amounts or amounts per hectare could be predicted satisfactorily for the North Island.

Comparisons between P use and P needs for farm classes for both North and South Islands could however be made on the amount of P per stock unit basis as variation in P needs per stock unit are dependent on the soil P loss factors. The amount of P per stock unit applied during the period of 1969-70 to 1984-85 in the South Island high country (0.74 kg P/su) was less than the long-term needs (1.13). However the average amount of P per stock

unit applied in South Island hill country during this period was equal to the P needs. In the North Island, in most years the level of P fertilisers applied has not been sufficient to replace all animal and soil P losses. In most MWBES farm classes, the anticipated decline in fertiliser inputs in the last two years is to about 50% of the long-term needs, and in North Island hard hill, 30% of these needs.

Comparison of kg P applied during 1981 (Statistics department or MWBES survey) showed reasonable agreement between the above two sets of data for the North Island when MWBES data was adjusted to include non sheep and cattle farming areas. However for the South Island there was less agreement between the sets of data where areas of farm classes predicted in the present study were not in agreement. For these above reasons, South Island MWBES farm class comparisons were more reliably done on a per stock unit basis.

5. Conclusions

The reliability and accuracy of the variables used in the calculation of P fertiliser requirements for New Zealand soils are the important considerations in this study. The fertiliser recommendation scheme (Cornforth and Sinclair, 1984) is accepted as a valid method for determination of P requirements for New Zealand soils, and is the best method currently available for estimations of P needs for New Zealand soils. Soils in this study were either classed as high producing or low producing depending on the presence of high producing pasture in the land capability unit.

Some checks between alternative sets of data allow an estimate of the reliability of the data used for this study. Stocking rates and areas from the MWD database were compared with stocking rates and areas obtained from the Statistics department, and there was close agreement between the two sets of data for North and South Island totals; variability within provinces was also within acceptable limits for this study. Stock unit totals calculated in this study for South Island Meat and Wool Board Economic Service farm classes did not however agree closely with stock units from the MWBES survey data for 1980-81. South Island MWBES farm classes were derived from the present land use of the soil sets (New Zealand Soil Bureau, 1968) and stocking rates were overestimated by this method for the South Island. Stocking rates for North Island MWBES farm classes were derived from MWD present land use descriptions of land capability units and agreed closely with the MWBES survey data. For the above reasons the amounts of P calculated in the study for maintenance on South Island MWBES farm classes are too high but those for the North Island MWBES farm classes are satisfactory. For these reasons, comparisons of P needs of MWBES farm classes in the South Island are best done on a per stock unit basis.

The amounts of P needed per stock unit for all South Island MWBES farm classes were similar (0.96 - 1.14, Table 4.7) and were quite different from the needs for North Island MWBES farm classes (1.43 - 1.52 kg P/su). The main cause of these differences is the dominant effect of higher soil P loss factors for soils in the North Island.

There were a large number of Olsen P analyses for South Island soils from the MAF soil testing service and means for the major soil groups for

1977-79 data and recent 1986 data were very similar, showing that the levels of Olsen P have not changed significantly since 1977-79 when the first set of analyses were done. Relative yields (i.e. level of pasture production) were similar to those of the top farmer for the South Island and it appears that farmers who have soils analysed intend to farm at the top farmer level. This could also mean that those farmers at average farmer stocking rates are not requesting as many soil analyses. It could also suggest that soils which have been fertilised and tested for Olsen P are being farmed at a higher level of production than the soils not being tested. Application of P fertiliser has also not apparently increased Olsen P levels in South Island soils. Comparison of another set of soil P levels of undeveloped soils from Truog P and citric acid P analyses with the Olsen P analyses for the South Island showed that similar responses to P fertilisers are predicted by both sets of data. Agreement of these two sets of data gives confirmation that the Olsen P analyses are representative samples of South Island undeveloped soils. These undeveloped soils are also quite high in P levels. Olsen P values for the North Island were derived from several sources, including a large number of citric acid and Truog P analyses. Olsen P values for undeveloped soils in the North Island (10.27 mean weighted for areas) were lower than for the South Island (13.70). Higher soil P losses in the North Island probably caused lower Olsen P levels, with higher P retention values (38.8 mean) for the North Island compared with 30.0 for the South Island.

Olsen P levels and P retentions of undeveloped soils in the South Island major soil groups were negatively correlated ($p \leq 0.05$). A similar trend was observed for North Island soils although the correlation was not significant. This dominant effect of soil P losses is shown in the effect of the soil P loss factor (SLF) on variations in P <u>needs</u> per stock unit for the North and South Island MWBES farm classes, and also mainly determines the variability in P needs per stock unit in the provinces (Table 3.7 and Figure 4.9).

Soil P losses are significantly correlated with P needs per stock unit, but animal losses do not show a close relationship to the amount of P needed per stock unit (Table 3.7 for the North Island). However for all the North Island the animal P loss factors were 0.94 kg P/Su for low producing pastures and 0.80 kg P/Su for high producing areas. Corresponding values for the South Island are 0.85 for low and 0.72 for high producing. These form a major part of P needs calculated in this study: 70% of P needs per

stock unit for the South Island and 58% for the North Island (when compared with North and South Island data in Table 4.7).

The lower proportion for the North Island reflects the higher soil P losses in the North Island.

While animal products are being exported in pastoral farming a gradual loss of P will occur. The alternatives to replacing this lost P in animal production and animal transfer are limited. Gillingham (1984) has suggested the extent to which trees (deciduous) can be used to modify the distribution of nutrients could usefully be considered, when discussing transfer in the dung of sheep in hill country. A long-term solution would be to have a different system of agriculture where nutrients are not removed from the locality where products are produced. However, while New Zealand is dependent on the export of agricultural products, this is not possible and P lost in animal products will need to be eventually replaced by the addition of fertilisers. About 20% of maintenance P fertiliser is needed to replace removed animal products (I. Cornforth, pers. comm.), and this amounts to a significant quantity of P exported each year (20% of totals given in Tables 4.4a, 4.4b, and 4.6).

The lack of Olsen P data for the North Island may not be critical in determining first year P needs for North Island soils. It appears from the high soil P loss factors and P retentions and the limited data on Olsen P levels that Olsen P levels are not high in the North Island. Comparison of first year with long-term P needs for North Island low producing pastures suggested that first year P needs were similar to long-term needs. If long-term P needs were met by fertilisers then first year P needs in the North Island would also appear to be covered. Relative yields of low producing and high producing North Island soils were high and fertiliser inputs will need to be maintained to sustain those levels of production.

Some North Island low producing soils must have received P fertiliser inputs to have achieved the current relative yields. There were advantages in separating soils into low and high producing areas as this gave an indication of the relative levels of production and associated P needs that could be expected for low and high producing areas.

The P requirements were initially calculated for soil sets in land use capability units. These units were common to all areas of New Zealand.

Summary groupings of P needs of soil sets could not be compared (except for Olsen P levels) with other data on P use, but the different properties of these major soil groups (e.g. South Island yellow-grey earths) are discussed in relation to the P needs. Some major soil groups with high soil P loss factors and P retention values would require larger investments of P for pasture establishment and maintenance than other major soil groups. Pasture utilisation (or relative yields, since both are derived from stocking rates) were low on some major soil groups in the South Island. Development in these areas would require more P per stock unit, and the possibility of improving the low pasture utilisations should be examined before relative yields were increased by application of P fertilisers.

The present P status of South Island soils was indicated by the requirements of first year P needs compared with long-term at different stocking rates and also by the Olsen P levels of the major soil groups. The Olsen P level determined whether more P was needed first year than for long-term at all stocking rates within the average or top farmer range of stocking rates. For the South Island low producing soils, if the Olsen P was below 10.2 for average and 12.4 for top farmer stocking rates then more P was needed first year than for long-term. For the South Island high producing soils more P was needed in the first year if Olsen P levels were below 11.0 at average farmer stocking rates. At top farmer stocking rates only one group of soils (peats) were below an Olsen P level of 13.5 and needed more P in the first year.

If only long-term P needs were met on those low producing pastures on soils that showed greater P needs for first year than for long-term then 2.9% less P fertilisers at average farmer and 15.6% less for top farmer stocking rates would be used compared with long-term for all soils. Since most of the South Island low producing soils needed less in the first year than for the long-term, fertiliser use would greatly exceed present needs if long-term rates were applied to all South Island soils: 45.5% more P than needed would be applied at average farmer stocking rates and 4.6% more for top farmer stocking rates (Tables 2.5, 2.6). Similarly for South Island high producing soils present P needs would be exceeded by 71% for average and 28.6% for top farmer stocking rates. It is apparent that soil testing for Olsen P levels in the South Island needs to be done primarily for economy of P use rather than for increasing applied P compared to long-term needs.

However soil testing for Olsen P of North Island soils would appear to be needed so that the higher P requirements because of uniformly high relative yields and high soil P losses were met. From the limited Olsen P data available it appeared that only two major groups of soils in the North Island did not require more P in the first year than for long-term. Olsen P levels were for "virgin" soils, whereas some of the low producing North Island soils have had P fertilisers, as was shown in Tables 4.3, 4.5, where the fertilised area in 1980-81 was greater than the high producing area for some of the North Island.

The relative yields of the South Island hill and high country were low, and have a considerable potential for improvement. Both relative yields and pasture utilisations are derived from the stocking rates and it cannot be determined in this study whether relative yields, pasture utilisations or both need to be improved. Examination of management of areas where there are low relative yields (or pasture utilisations) should determine which factors) need to be improved. Relative yields (or pasture utilisations) of North Island soils were high for all three farm classes, showing the reduced opportunities for development in the North Island and continued dependence on P fertilisers.

Changes in pasture utilisation for South Island low producing soils from the present 52.4% to 60% would give an expected increase of 2.57 million s.u. without increasing the need of P per stock unit. Increasing pasture utilisation from 52 to 85% on South Island low producing soils would decrease the need of P per stock unit from 1.0 to 0.6 kg P/su. Soil P losses would still amount to 0.5 kg P/su at all stocking rates and unless P fertilisers are used the fertiliser model predicts that the low producing pastures will be gradually depleted. Even at high P fertiliser rates South Island low producing soils would need to have improved pasture utilisations or the average farmer stocking rates could only increase by about a maximum of one stock unit per hectare.

On South Island high producing pastures if the stocking rate at the top farmer level was reduced by 0.5 su/ha then the same amount of P/su would be needed for average and top farmer stocking rates on high producing areas.

Farming at the potential farmer stocking rate needs generally high rates of P (Figures 3.1, 3.2). However where there are lower soil P loss factors

less P is needed per stock unit and even at potential farmer stocking rates kg P/su may be less than that of a high P loss soil at average farmer stocking rates: North Island yellow brown loams and intergrades need 1.61 kg P/su at average farmer stocking rates (Table 3.7) while South Island high country yellow grey earths need 0.9 kg P/su at potential farmer stocking rates.

Within each soil group there are possibilities for improving efficiency of P use by choosing appropriate stocking rates, pasture utilisations and relative yields, but there are major differences in kg P needs per stock unit between major soil groups and between provinces of the North Island where there is a range of soil loss factors. Soil loss factors are significantly correlated with needs of P/su for North Island major soil groups (r^2 = 0.86) for provinces (r^2 = 0.94) and for MWBES farm classes (r^2 = 0.93).

Low producing pastures on South Island high country yellow grey earths have low stocking rates in relation to their potential (i.e. low relative yields or pasture utilisations). Present Olsen P levels indicate that only 0.44 kg P/ha would be needed for first year P requirements on these soils. Factor(s) causing the low stocking rates could be sulphur deficiency, lack of suitable agronomic species such as clovers and lack of stock when there is a surplus of pasture, as winter stock carrying capacity determines spring and summer stocking rates. Lack of subdivision resulting in low grazing pressures during spring and summer is also another cause of poor utilisation.

The P fertiliser applied for maintenance in the South Island during 1981 (44 m kg) was the same as the long-term P needs at average farmer stocking rates (including low and high producing). As some of the low producing pastures has received P fertilisers, more than long-term needs have been applied to some South Island high producing pastures. The amount applied also considerably exceeds the 9 m kg of P needed if high producing pastures only had been fertilised for first year P at average farmer stocking rates. It also appears from the earlier discussion on South Island Olsen P levels that there has been a representative sampling of South Island soils used in this study so that it is important for reasons of economy in P use that soils are tested for Olsen P. Olsen P levels of South Island soils have stayed high in the last ten years and long-term rates of P applied must have maintained these levels.

The 9 m kg first-year P needs is much less than that applied on high producing soils in 1981. This reduction is less than that observed in 1986 for South Island soils (A. Sinclair, pers. comm.) when first-year P needs were about 75% of long-term P needs. Relative yields of the data used for soil testing which A.Sinclair based his observations on were similar to those of the top farmer (Table 1.10): top farmer first-year P needs are considerably more than for the average farmer (Table 4.2), and the higher relative yields for farms which are soil tested would account for the above differences.

The time series data on P use per stock unit for MWBES farm classes (Figures 4.3, 4.4, 4.5 and Table 4.7) showed that less P was applied in 1980-81 than was needed for the South Island high country, adequate P in the South Island hill country, and extra P in the South Island intensive finishing farms.

Fertiliser P applied in the North Island was inadequate to replace P losses at average farmer stocking rates in 1981 in the provinces of East Coast, Taranaki, Wellington and Auckland/Bay of Plenty (Table 4.2). This deficit occurred in the more intensive land use areas (North Island intensive finishing farms) which included all intensively used areas as well as sheep and cattle farming (Table 4.4a). The Bay of Plenty has more than half the dairy cattle in the North Island (8.2 m s.u., Table 2.1) and the MWBES rate was only for sheep and cattle farming. The total applied P on North Island intensively used areas (i.e. intensive finishing farms in this study) was probably about 50 m kg, rather than 43.7 m kg (Table 4.4a).

Although North Island hard hill and North Island easier hill had sufficient P applied in 1981 (Table 4.4a), longer term trends show that there has been a decline in P use per stock unit since 1980, so that in 1986-87 only 30% of P needs are forecast to be applied on North Island hard hill areas. It is also apparent that a greater part of the North Island has been improved and fertilised (Table 4.3). As it seems likely that North Island low producing pastures are low in fertility compared with South Island low producing, continued reliance on P fertilisers would appear necessary to maintain the high relative yields and replace the expected high soil P losses.

If production from the New Zealand pastoral industry were to increase to

the level of the top farmer, then annual long-term P needs would be about double the amount applied during 1981.

North Island hard hill farms are mostly in Wellington, Auckland/Bay of Plenty and Taranaki. Steepland soils form the largest proportion of the areas of hard hill. Development of soils in recent years has probably occurred on these steepland soils, and although it appears some of these soils are no lower in fertility than soils on easier country these soils would quickly revert to scrub if fertiliser inputs were not maintained. A recent example of the role of topdressing in providing a productive grass cover and an income for catchment protection has been shown by the successes in the Tinui district, in the Waiarapa (WASCO, 1987). Successful control of erosion depends on sufficient profitability of farming in these areas, which is dependent on phosphorus inputs. Cessation of fertiliser use on the less productive hill areas could lead to eventual lack of erosion control and return to pre-erosion control disasters.

The dominant effect of soil P loss factors on the amount of P needed per stock unit and the gradual run-down in application of fertilisers has produced difficult problems for the pastoral industry. Some alternative courses of action at present appear to be the following:

(a) If the pastoral industry continues in the present course with the decline in fertiliser P use soils will become eventually depleted and unproductive.

(b) Maintenance of adequate levels of phosphate use appears unlikely under the present economic returns, particularly in the North Island. If pastoral production were to increase to the level of the top farmers, double the present P use would be needed. Whether resources of phosphate fertilisers are available to meet these needs should also be considered although it is unlikely that financial resources would be available.

(c) The soil P losses relationship to the amount of P needed should be examined closely. Is there a way of influencing this dominant factor? O'Connor (1986) has found that deep rooting species such as trees can concentrate P in the top horizon compared with areas without trees. He has also suggested that pastoral agriculture is dependent on the accumulation of P in top soils achieved by previous bush that has since disappeared. The only real alternative in the long-term could be to make use of

alternative species of plants which could reverse the high soil P losses and reduce the demand for external phosphorus resources. A more sustainable form of land use needs to be investigated and a good starting point appears to be more extensive studies of alternative systems of land use which could reverse the present large P losses from the system.

(d) Another alternative suggested earlier was to confine pastoral production to soils where soil P losses are lower to make better use of P fertilisers. This would not be practical considering most of the North Island soils are in the higher soil P loss areas. Animal transfer losses are lower on some North Island soils, but only two of the the North Island major soil groups fall into this category.

(e) More studies could be undertaken on soil P losses to determine where losses occur (e.g. leaching, fixation) and alternative methods (in addition to the ones above) could be found to stem these large annual losses of P from the top soil.

While there is a variability of soil P losses throughout New Zealand soils, animal losses of P through fertility transfer and animal products form a consistently high loss of P throughout New Zealand. There may be some possibility of reducing animal transfer losses on hill country by controlling stock movements, but the loss in animal products is an unavoidable loss while pastoral products are exported. In the long-term, when phosphate fertiliser resources have been exhausted, agriculture may have to change to a system where there is recycling of nutrients in the locality where pastoral products are produced.

References

Blakemore, L.C. 1956: Chemistry of the intra-zonal line - rich soils of New Zealand. New Zealand Soil News, August 1956: 210-212.

Blakemore, L.C. 1960: Chemistry of yellow-brown province soils. New Zealand Soil News, February 1960. 245-248. In: Soil Groups of New Zealand (unpublished).

Bruce, J.G. 1978: Soils of Part Raglan County, South Auckland, Soil Bureau Bulletin 41. New Zealand Department of Scientific and Industrial Research.

Campbell, I.B. 1977: Soils of Part Wanganui County. Soil Bureau Bulletin 40. New Zealand Department of Scientific and Industrial Research.

Cornforth, I.S. 1982: Soils and Fertilisers, Soil Analysis, Interpretation. Aglink publication, Ministry of Agriculture and Fisheries.

Cornforth, I.S.; Sinclair, A.G. 1984: Fertiliser recommendations for pasture and crops in New Zealand, Agricultural Research and Advisory Services Divisions, New Zealand Ministry of Agriculture and Fisheries, Wellington.

Cox, J.E. 1978: Soils and Agriculture of Part Paparua County. Soil Bureau Bulletin 34. New Zealand Department of Scientific and Industrial Research.

Cowie, J.D. 1978: Soils and Agriculture of Kairanga County, North Island, New Zealand. New Zealand Soil Bureau Bulletin 33. New Zealand Department of Scientific and Industrial Research.

Darkey, C.K.G. 1985: A systems approach to the economic evaluation of nitrogen fertiliser use in sheep farming enterprises. Ph.D. thesis, Lincoln College, New Zealand.

Dixon, J.K.; Metson, A.J. 1954. Appendix 2 - notes on chemical analysis and determination of lime requirement. In: New Zealand Soil Bureau, General survey of the soils of the North Island, New Zealand, Soil Bureau Bulletin 5. New Zealand Department of Scientific and Industrial Research.

Gibbs, H.S. 1980: In: Soil Groups of New Zealand, Part 5, Podzols and Gley Podzols. New Zealand Society of Soil Science: 18-24.

Gillingham, A.G.; Syers, J.K.; Gregg, P.E.H. 1984 Nutrient cycling and management in grazed pastures. New Zealand Agricultural Science 18, No.3: 115-118.

Grigg, J.L. 1980: Phosphate retention in South Island soils. Ministry of Agriculture and Fisheries Technical Report no. 9. June 1980.

Hupkens van der Elst, F.C.C. 1958: Problems in development of peat soils. New Zealand Soil News. New Zealand Society of Soil Science: 179-191. In: Soil Groups of New Zealand (unpublished).

Kerr, I.G.C.; Lefever, K.R.; Costello, E.J. 1980: Livestock production and performance in South Island high country. Tussock Grasslands and Mountain Lands Institute review 38: 2-15.

Kerr, I.G.C.; Lefever, K.R. 1984: High country farming 1966-1982. Tussock Grasslands and Mountain Lands Institute review 42: 59-82.

Metson, A.J.; Cox, J.E. 1978: Soil chemistry. In: Soils and Agriculture of Part Paparua County, Canterbury, New Zealand. Soil Bureau Bulletin 34. New Zealand Department of Scientific and Industrial Research.

Miller, R.B. 1968: Soil chemistry. In: General survey of the soils of the South Island, New Zealand. New Zealand Soil Bureau Bulletin 27. New Zealand Department of Scientific and Industrial Research.

Ministry of Agriculture and Fisheries. 1967: Soil sampling codes, South Island. Circular 66/FR/2.

National Water and Soil Conservation Organisation. 1981: New Zealand Land Resource Inventory Survey, stock carrying capacities and fertiliser data for the North Island. Internal report No.22. Ministry of Works and Development.

National Water and Soil Conservation Organisation. 1987: The Whareama story. Waiarapa Catchment Board. WASCO 64.

New Zealand Soil Bureau. 1954: General survey of the soils of the North Island, New Zealand. New Zealand Soil Bureau Bulletin 5, Department of Scientific and Industrial Research.

New Zealand Soil Bureau. 1968: General survey of the soils of the South Island, New Zealand. New Zealand Soil Bureau Bulletin 27. New Zealand Department of Scientific and Industrial Research.

O'Connor, K.F. 1986: Roles for forestry in high country land use. Tussock Grasslands and Mountain Lands Institute Review 43: 83-94.

Pullar, W.A.; Hewitt, S.R.; Heine, J.C. 1978: Soils and land uses of Whakatane Borough and environs, Bay of Plenty, New Zealand. New Zealand Soil Bureau Bulletin 38. New Zealand Department of Scientific and Industrial Research.

Rijske, W.C. 1977: Soils of Pohangiha County. New Zealand Soil Bureau Bulletin 42. New Zealand Department of Scientific and Industrial Research.

Saunders, W.M.H. 1965: Phosophate retention by New Zealand soils and its relationship to free sesquioxides, organic matter and other soil properties. New Zealand Journal of Agricultural Research 8: 30-57.

Saunders, W.M.H. 1968: Phosphorus. In: Soils of New Zealand Part 2. Soil Bureau Bulletin 26(2). New Zealand Department of Scientific and Industrial Research.

Scobie, G.M.; St-Pierre, N. R. 1987a: Economics of phosphorus fertiliser use on pastures. 1. Long-run maintenance requirements. New Zealand journal of experimental agriculture 15: 435-443

--------1987b: Economics of phosphorus fertiliser use on pastures. 2. Incorporating the residual effect. New Zealand journal of experimental agriculture 15: 445-451

Sherrell, C.G. 1970: Comparison of chemical extraction methods for the determination of "available" phosphate in soils I. Correlation between methods and yield and phosphorus uptake by white clover grown on 16 North Island soils in the glasshouse. New Zealand Journal of Agricultural Research 13. No.3: 481-493.

Sinclair, A.G.; Cornforth, I.S. 1984: A modification of the "Superchoice" phosphate maintenance model. New Zealand Journal of Experimental Agriculture 12: 141-144.

Soil Conservation and Rivers Control Council 1971: Land use capability survey handbook. Water and Soil Division, Ministry of Works, Wellington.

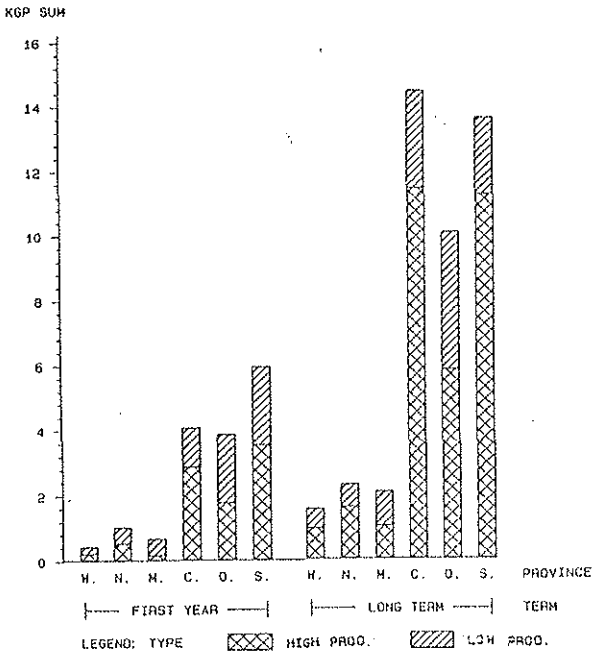
St-Pierre, N. R.; Scobie, G. M. 1987: Economics of phosphorus use on pastures. 3. Incorporating animal response. New Zealand journal of experimental agriculture 15 : 453-462.

---------- 1987: Economics of phosphorus use on pastures. 4. Incorporating risk. New Zealand journal of experimental agriculture 15 : 463-475.

Taylor, N.H.; Pohlen, I.J. 1970: Soil survey method. A New Zealand handbook for the field study of soils. Soil Bureau Bulletin 25. New Zealand Department of Scientific and Industrial Research.

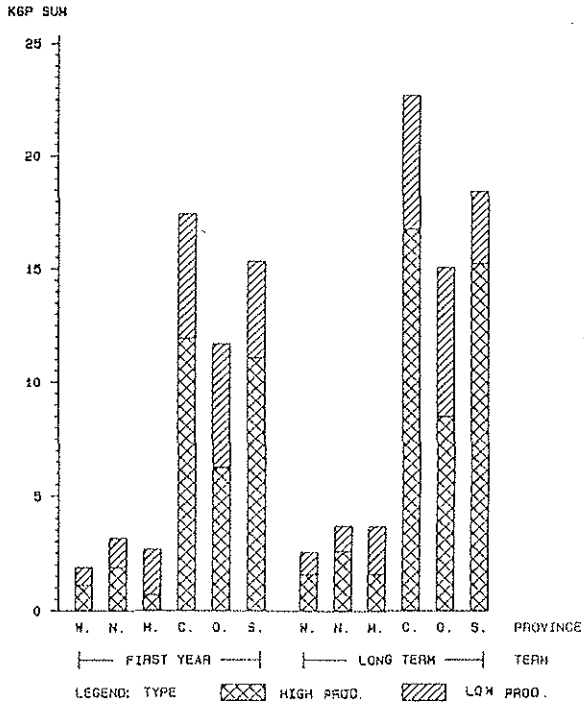
Ward, J.C.; Talbot, J.M.; Denne, T.; Abrahamson, M. 1985: Phosphorous losses through transfer, soil erosion and run off: processes and implications. Information paper, Centre for Resource Management, Lincoln College.

APPENDIX 1 P MAINTENANCE NEEDS (million kg) OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES



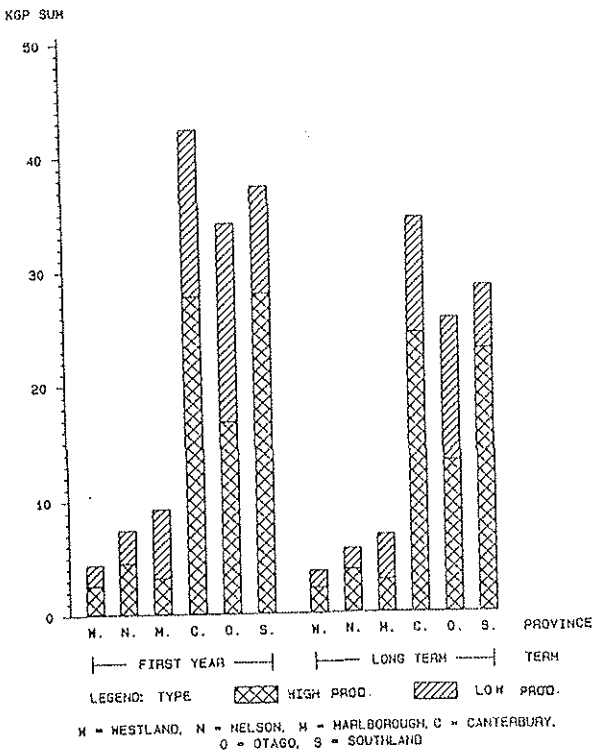
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 2 P MAINTENANCE NEEDS (million kg) OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES



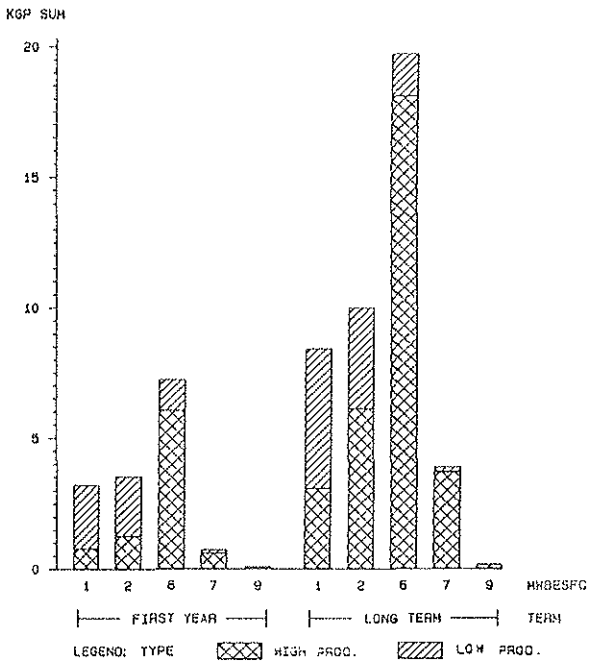
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 3 P MAINTENANCE NEEDS (million kg) OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 4 P MAINTENANCE NEEDS, (million kg) ,OF MAJOR FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING AT AVERAGE FARMER STOCKING RATES



1 = HIGH COUNTRY, S.I. 2 = HILL COUNTRY, S.I.
6 = FINISH-BREEDING, S.I. 7 = INTENSIVE-FINISHING, SI.
9 = MIXED CROPPING & FINISH.

APPENDIX 4 P MAINTENANCE NEEDS (kg) OF MWBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
1	784379.00	3094528.00	2427071.00	5351693.00
2	1280849.00	6146599.00	2256154.00	3863221.00
6	6052963.00	18130899.00	1181188.00	1619012.00
7	617470.00	3731555.00	130893.00	173914.00
9	87660.00	170300.00	0.00	0.00
ALL	8823321.00	31273881.00	5995306.00	11007840.00

1 = HIGH COUNTRY,S.I. 2 = HILL COUNTRY,S.I.
6 = FINISH-BREEDING,S.I. 7 = INTENSIVE-FINISHING,SI.
9 = MIXED CROPPING & FINISHING FARMS

APPENDIX 5 P MAINTENANCE NEEDS (kg) OF MWBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
1	3704250.00	4579155.00	7825240.00	9511288.00
2	6221069.00	9173702.00	7099917.00	6481361.00
6	19303975.00	26285063.00	2658711.00	2461258.00
7	2972120.00	5101892.00	246873.00	233660.00
9	230294.00	275281.00	0.00	0.00
ALL	32431708.00	45415093.00	17830741.00	18687567.00

1 = HIGH COUNTRY,S.I. 2 = HILL COUNTRY,S.I.
6 = FINISH-BREEDING,S.I. 7 = INTENSIVE-FINISHING,SI.
9 = MIXED CROPPING & FINISHING FARMS

APPENDIX 6 P MAINTENANCE NEEDS (kg) OF MWBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
1	16895947.00	7092360.00	25346333.00	18098120.00
2	16895947.00	14108701.00	16585919.00	10640721.00
6	46650769.00	38795084.00	5948869.00	3876484.00
7	7648675.00	7250268.00	464824.00	329652.00
9	407250.00	356992.00	0.00	0.00
ALL	88498588.00	67603405.00	48345945.00	32944977.00

1 = HIGH COUNTRY,S.I. 2 = HILL COUNTRY,S.I.
6 = FINISH-BREEDING,S.I. 7 = INTENSIVE-FINISHING,SI.
9 = MIXED CROPPING & FINISHING FARMS

APPENDIX 1 P MAINTENANCE NEEDS, (kg) ,OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	209587.00	931067.00	202124.00	595165.00
N.	513471.00	1574616.00	490962.00	702077.00
M.	153876.00	995785.00	497999.00	1054330.00
C.	2854745.00	11408164.00	1194271.00	2999872.00
O.	1753564.00	5803667.00	2091741.00	4236600.00
S.	3518197.00	11225406.00	2400211.00	2356087.00
ALL	9003440.00	31938705.00	6877308.00	11944131.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 2 P MAINTENANCE NEEDS, (kg) ,OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	1120894.00	1576465.00	762583.00	970824.00
N.	1887790.00	2582352.00	1263924.00	1117988.00
M.	691644.00	1612732.00	1956631.00	2071357.00
C.	11932050.00	16786466.00	5504373.00	5917623.00
O.	6238427.00	8492120.00	5451872.00	6593804.00
S.	11066584.00	15259646.00	4279806.00	3218712.00
ALL	32937389.00	46309781.00	19219189.00	19890308.00

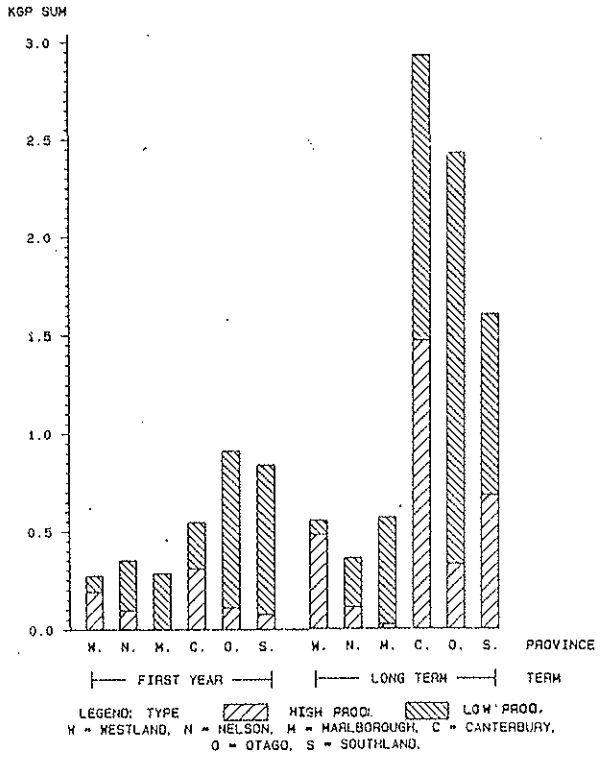
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 3 P MAINTENANCE NEEDS, (kg) ,OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

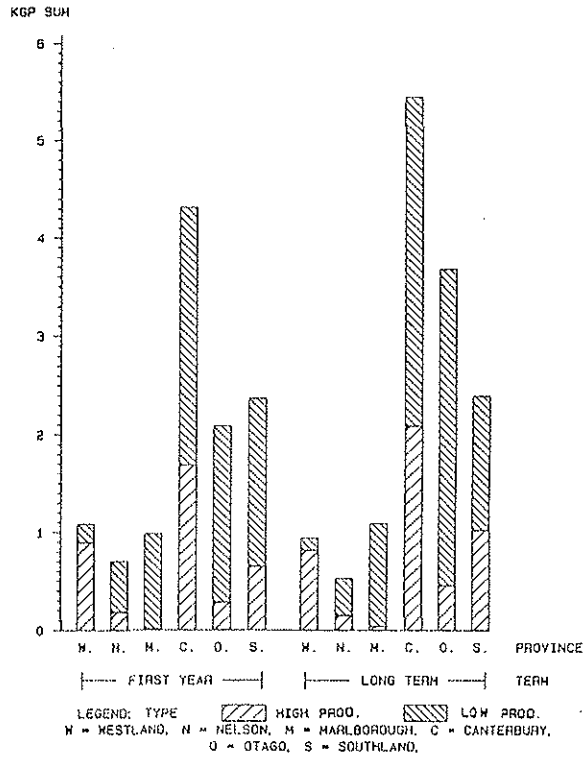
	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	2515033.00	2222070.00	1831921.00	1443704.00
N.	4465221.00	3728190.00	2915640.00	1838287.00
M.	3156610.00	2833815.00	6096742.00	3958154.00
C.	27732856.00	24403661.00	14586860.00	10089065.00
O.	16738705.00	13222856.00	17430027.00	12460147.00
S.	27978688.00	22946847.00	9394118.00	5556263.00
ALL	82587113.00	69357439.00	52255308.00	35345620.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

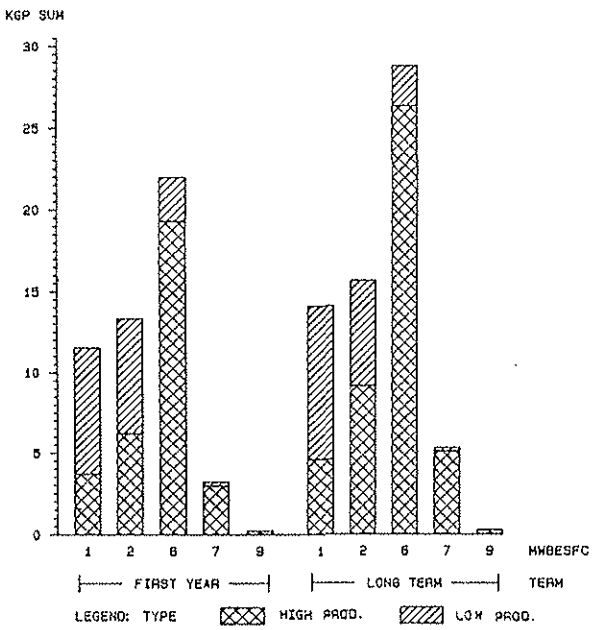
APPENDIX 7 P MAINTENANCE NEEDS (million KG) OF S.I. HIGH COUNTRY IN PROVINCES , FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING AT AVERAGE FARMER STOCKING RATES



APPENDIX 8 P MAINTENANCE NEEDS (million Kg) OF S.I. HIGH COUNTRY IN PROVINCES , FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

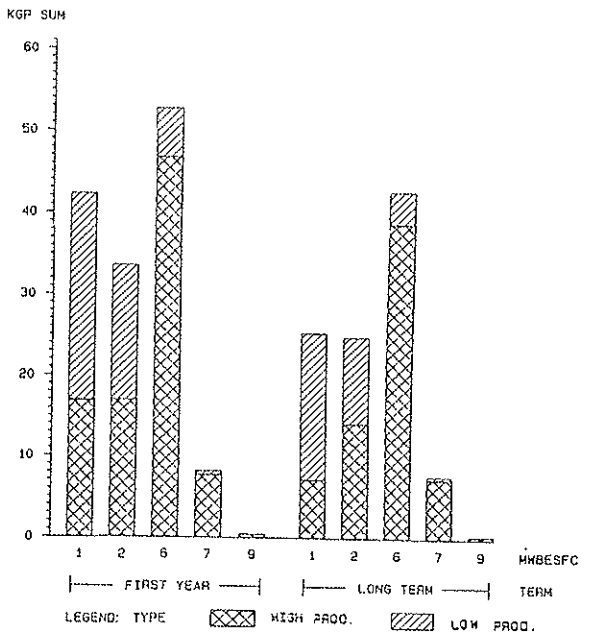


APPENDIX 5 P MAINTENANCE NEEDS, (million kg) ,OF NWBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING AT TOP FARMER STOCKING RATES



1 = HIGH COUNTRY, S.I. 2 = HILL COUNTRY, S.I.
6 = FINISH-BREEDING, S.I. 7 = INTENSIVE-FINISHING, SI.
9 = MIXED CROPPING & FINISH.

APPENDIX 6 P MAINTENANCE NEEDS, (million kg) ,OF NWBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING AT POTENTIAL FARMER STOCKING RATES



1 = HIGH COUNTRY, S.I. 2 = HILL COUNTRY, S.I.
6 = FINISH-BREEDING, S.I. 7 = INTENSIVE-FINISHING, SI.
9 = MIXED CROPPING & FINISH.

APPENDIX 7 P MAINTENANCE NEEDS (kg) S.I. HIGH COUNTRY IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	191630.00	480166.00	81199.00	72956.00
N.	95782.00	109376.00	256675.00	252763.00
M.	2135.00	23399.00	284170.00	545375.00
C.	308521.00	1467697.00	238634.00	1462572.00
O.	109666.00	329758.00	803401.00	2098097.00
S.	76645.00	684132.00	762992.00	919930.00
ALL	784379.00	3094528.00	2427071.00	5351693.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 8 P MAINTENANCE NEEDS (kg) OF S.I. HIGH COUNTRY IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	895564.00	815770.00	187028.00	125237.00
N.	184726.00	149779.00	517379.00	372177.00
M.	7297.00	36736.00	972709.00	1054776.00
C.	1687514.00	2094221.00	2618873.00	3357708.00
O.	280314.00	457052.00	1806999.00	3225539.00
S.	648834.00	1025597.00	1722252.00	1375852.00
ALL	3704249.00	4579155.00	7825240.00	9511289.00

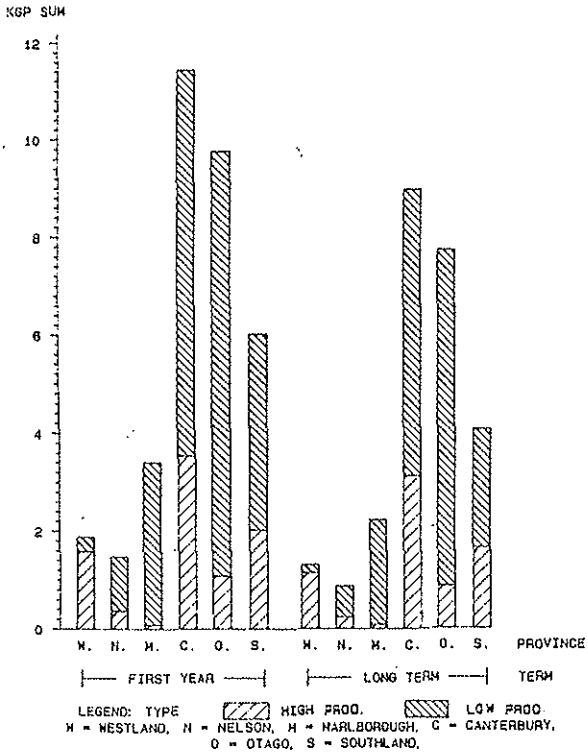
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 9 P MAINTENANCE NEEDS (kg) OF S.I. HIGH COUNTRY IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

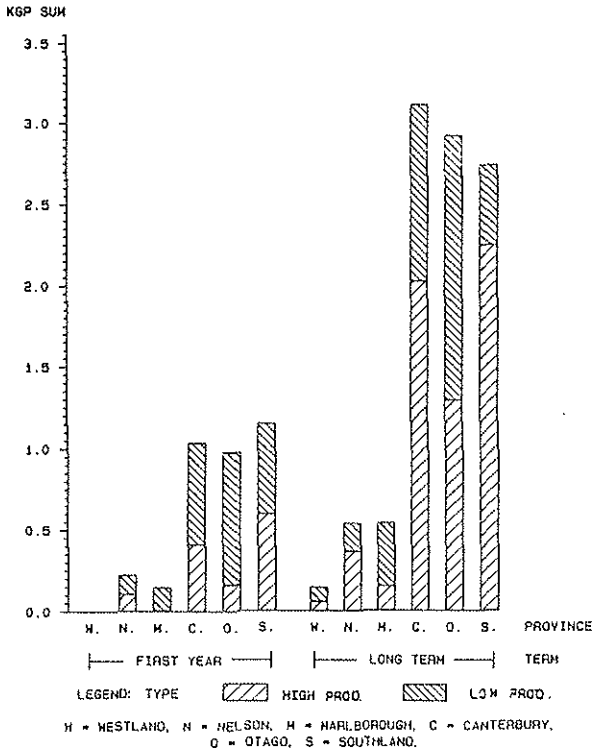
	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	1588493.00	1138276.00	299289.00	174240.00
N.	367056.00	233128.00	1113883.00	637304.00
M.	81508.00	81378.00	3340004.00	2145795.00
C.	3541037.00	3134180.00	7903916.00	5850403.00
O.	1073315.00	856343.00	8688793.00	6865009.00
S.	2023462.00	1649055.00	4000448.00	2425368.00
ALL	8674871.00	7092360.00	25346333.00	18098119.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

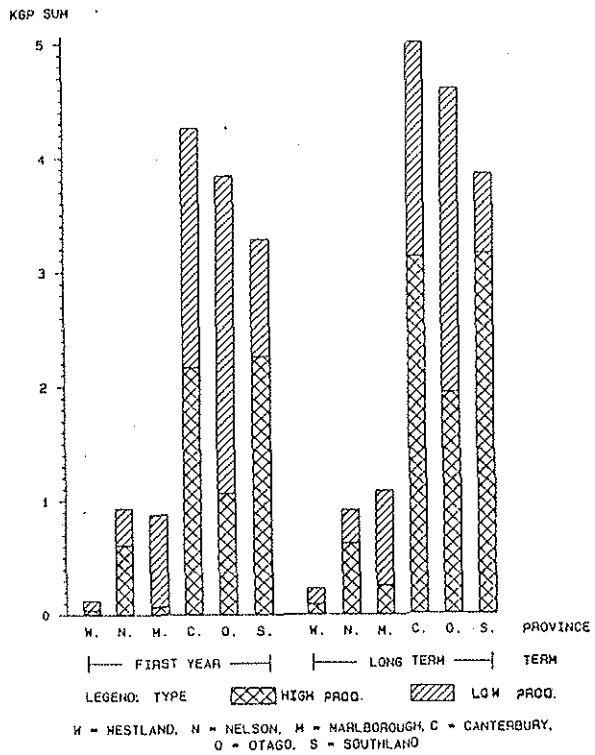
APPENDIX 9 P MAINTENANCE NEEDS (million Kg) OF S.I.
HIGH COUNTRY IN PROVINCES, FIRST YEAR AND LONG-TERM FOR
LOW AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES



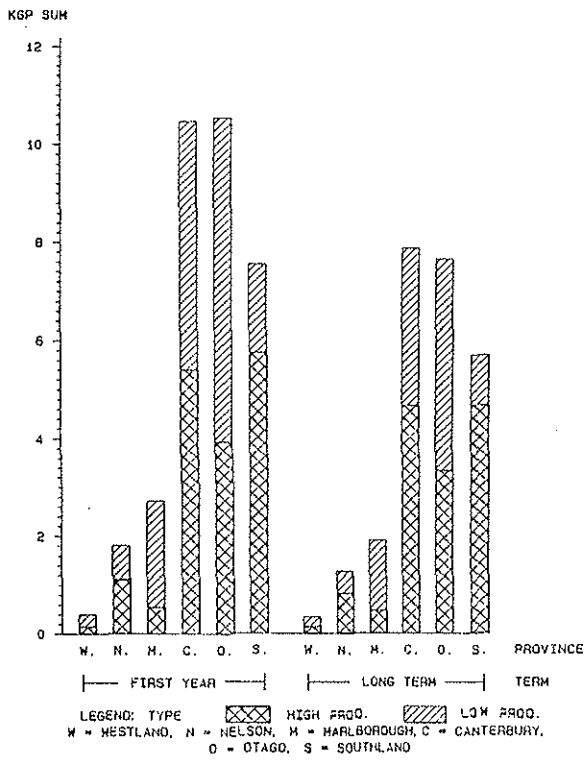
APPENDIX 10 P MAINTENANCE NEEDS (million KG) OF S.I.
HILL COUNTRY, IN PROVINCES, FIRST YEAR AND LONG-TERM FOR
LOW AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES



APPENDIX 11 P MAINTENANCE NEEDS (million Kg) OF S.I.
HILL COUNTRY IN PROVINCES, FIRST YEAR AND LONG-TERM
FOR LOW AND HIGH PRODUCING AT TOP FARMER STOCKING RATES



APPENDIX 12 P MAINTENANCE NEEDS (million Kg) OF S.I.
HILL COUNTRY IN PROVINCES, FIRST YEAR AND LONG-TERM FOR
LOW AND HIGH PRODUCING AT POTENTIAL FARMER STOCKING RATES



APPENDIX 10 P MAINTENANCE NEEDS (kg) S.I. HILL COUNTRY IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	103.00	57456.00	0.00	87442.00
N.	105542.00	364892.00	116875.00	176193.00
M.	3111.00	149225.00	143975.00	393615.00
C.	412613.00	2028392.00	623856.00	1087130.00
O.	162383.00	1295880.00	817325.00	1626274.00
S.	597097.00	2250754.00	554123.00	492568.00
ALL	1280849.00	6146599.00	2256154.00	3863222.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 11 P MAINTENANCE NEEDS (kg) OF S.I. HILL COUNTRY IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	41813.00	90206.00	82673.00	137788.00
N.	613213.00	623147.00	319335.00	290525.00
M.	70035.00	252914.00	808348.00	829810.00
C.	2168332.00	3117676.00	2091616.00	1875020.00
O.	1065150.00	1938637.00	2777995.00	2650965.00
ALL	6221070.00	9173704.00	7099916.00	6481359.00

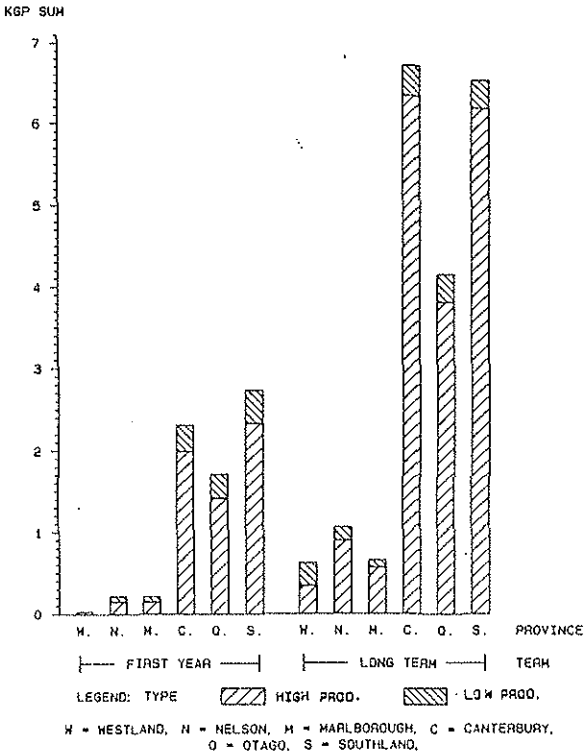
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 12 P MAINTENANCE NEEDS (kg) OF S.I. HILL COUNTRY IN PROVINCES , FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	149691.00	137691.00	249651.00	208042.00
N.	1113446.00	824767.00	697981.00	457060.00
M.	544611.00	469992.00	2175954.00	1438704.00
C.	5402610.00	4666137.00	5061825.00	3200059.00
O.	3942062.00	3336345.00	6600934.00	4315909.00
S.	5743527.00	4673769.00	1799573.00	1020952.00
ALL	16895947.00	14108701.00	16585918.00	10640726.00

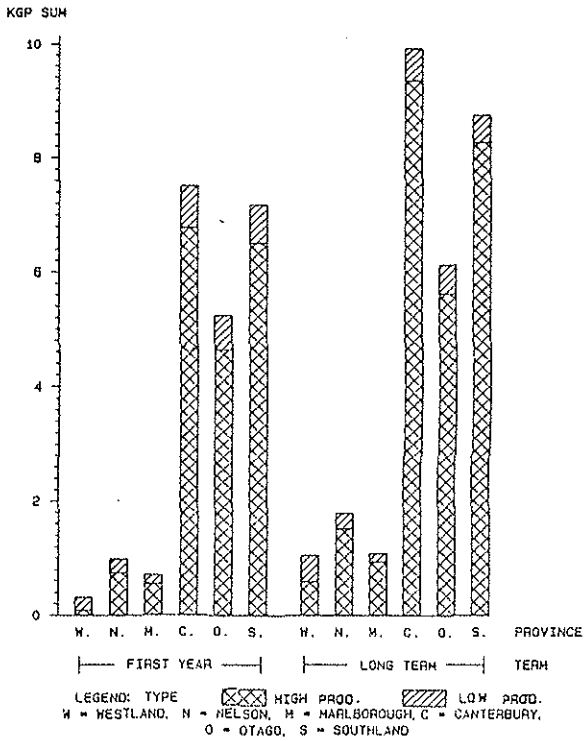
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 13 P MAINTENANCE NEEDS (million KG) OF S.I. FINISHING - BREEDING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM, FOR LOW AND HIGH PRODUCING AT AVERAGE FARMER STOCKING RATES



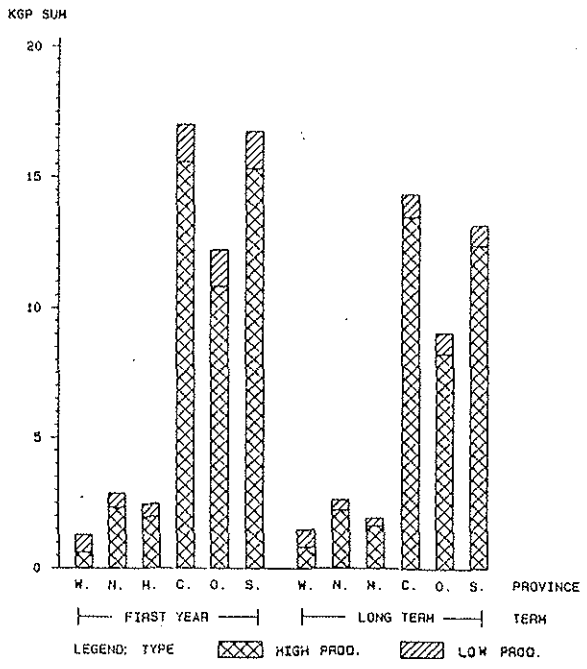
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND.

APPENDIX 14 P MAINTENANCE NEEDS (million Kg) OF S.I. FINISHING-BREEDING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES



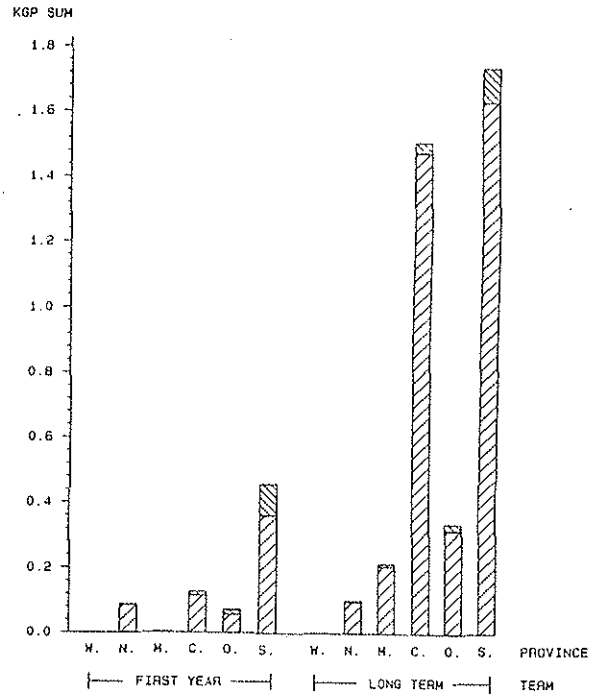
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 15 P MAINTENANCE NEEDS (million Kg) OF S.I. FINISHING- BREEDING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 16 P MAINTENANCE NEEDS (million KG) OF S.I. INTENSIVE - FINISHING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM, FOR LOW AND HIGH PRODUCING AT AVERAGE FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND.

APPENDIX 13 P MAINTENANCE NEEDS (kg) S.I. FINISHING-BREEDING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	91.00	345754.00	34075.00	279425.00
N.	153768.00	895686.00	65224.00	167391.00
M.	148630.00	567372.00	66125.00	90032.00
C.	1997250.00	6333063.00	316813.00	385564.00
O.	1416321.00	3813894.00	298459.00	342685.00
S.	2336903.00	6175131.00	400491.00	353914.00
ALL	6052963.00	18130900.00	1181187.00	1619011.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 14 P MAINTENANCE NEEDS (kg) S.I. FINISHING-BREEDING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	94985.00	588605.00	227670.00	465026.00
N.	742855.00	1511011.00	249182.00	284157.00
M.	544351.00	936332.00	165287.00	154222.00
C.	6772907.00	9350395.00	731935.00	583315.00
O.	4636978.00	5627363.00	610080.00	503455.00
S.	6511899.00	8271358.00	674557.00	471083.00
ALL	19303975.00	26285064.00	2658711.00	2461258.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 15 P MAINTENANCE NEEDS (kg) S.I. FINISHING-BREEDING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	617432.00	831469.00	672713.00	664527.00
N.	2332229.00	2226061.00	546313.00	408034.00
M.	1971931.00	1624601.00	494366.00	301670.00
C.	15570219.00	13475512.00	1437872.00	884458.00
O.	10831465.00	8265471.00	1372804.00	832025.00
S.	15327492.00	12371969.00	1424800.00	785772.00
ALL	46650768.00	38795083.00	5948868.00	3876486.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 16 P MAINTENANCE NEEDS (kg) S.I. INTENSIVE-FINISHING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	437.00	1687.00	0.00	0.00
N.	84918.00	96185.00	3493.00	3494.00
M.	0.00	204791.00	3716.00	3716.00
C.	114388.00	1478353.00	12457.00	12457.00
O.	56535.00	316192.00	14751.00	14751.00
S.	361193.00	1634348.00	96475.00	96475.00
ALL	617471.00	3731556.00	130892.00	130893.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 17 P MAINTENANCE NEEDS (kg) S.I. INTENSIVE-FINISHING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	5619.00	4043.00	0.00	0.00
N.	148703.00	124850.00	5068.00	5631.00
M.	69709.00	292030.00	10275.00	13037.00
C.	1178387.00	2063000.00	32559.00	44234.00
O.	231044.00	405863.00	23991.00	24942.00
S.	1338660.00	2212026.00	174980.00	145816.00
ALL	2972122.00	5101892.00	246873.00	233660.00

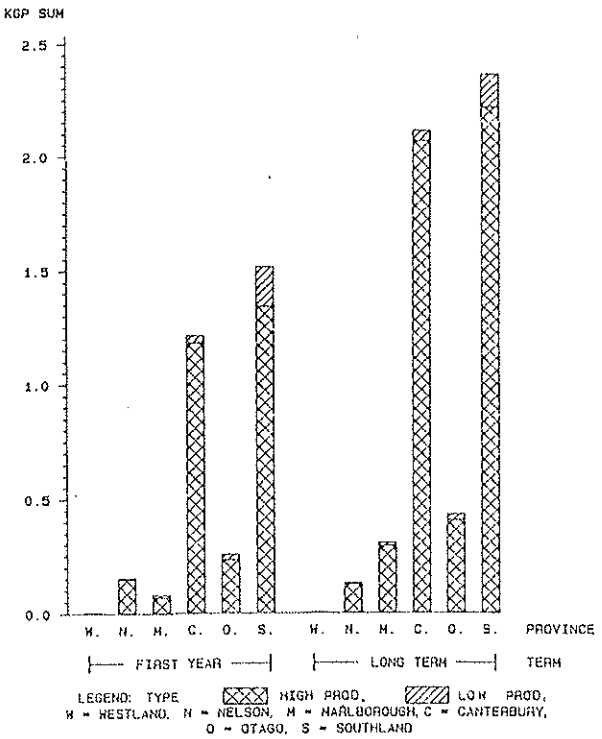
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 18 P MAINTENANCE NEEDS (kg) S.I. INTENSIVE-FINISHING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	6624.00	4623.00	0.00	0.00
N.	263878.00	183231.00	15143.00	10095.00
M.	465222.00	516338.00	32806.00	23287.00
C.	2984759.00	2921642.00	69967.00	60302.00
O.	716661.00	625099.00	51247.00	38859.00
S.	3211530.00	2999335.00	295661.00	197108.00
ALL	7648674.00	7250268.00	464824.00	329651.00

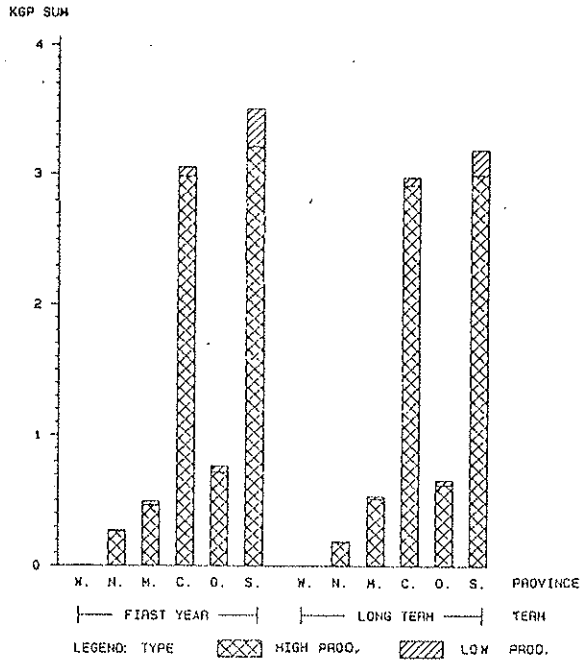
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 17 P MAINTENANCE NEEDS (million Kg) OF S.I. INTENSIVE- FINISHING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES



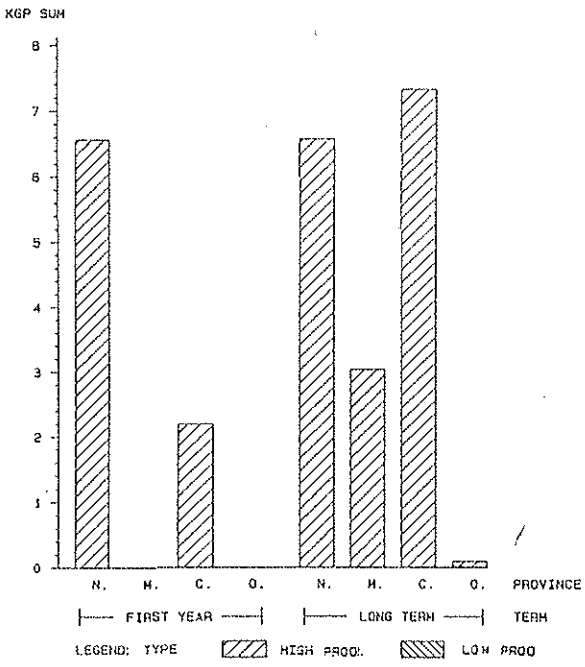
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 18 P MAINTENANCE NEEDS (million Kg) OF S.I. INTENSIVE- FINISHING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES



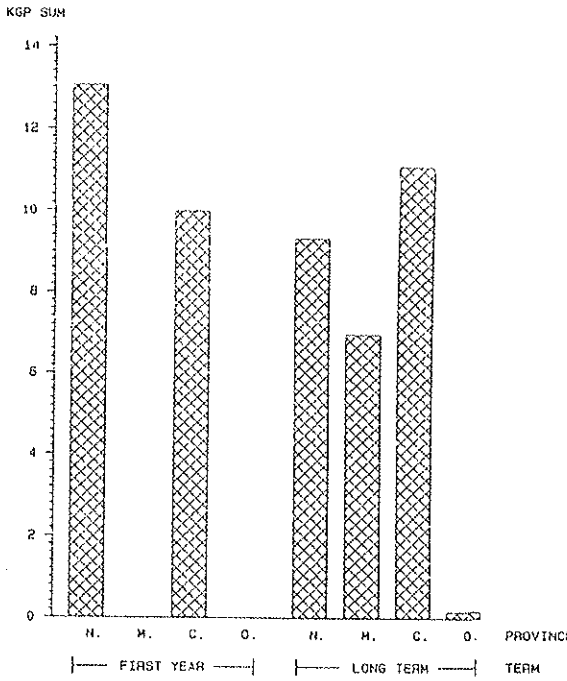
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 19 P MAINTENANCE NEEDS (Kgx10,000) OF S.I. MIXED CROPPING AND FINISHING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES



N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO

APPENDIX 20 P MAINTENANCE NEEDS (KGX10,000) OF S.I. MIXED-CROPPING AND FINISHING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTU AT TOP FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 19 P MAINTENANCE NEEDS (kg) S.I. MIXED CROPPING AND FINISHING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
N.	65688.00	65688.00	0.00	0.00
M.	0.00	30405.00	0.00	0.00
C.	21973.00	73242.00	0.00	0.00
O.	0.00	965.00	0.00	0.00
ALL	87661.00	170300.00	0.00	0.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 20 P MAINTENANCE NEEDS (kg) S.I. MIXED CROPPING AND FINISHING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT TOP FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
N.	130475.00	93196.00	0.00	0.00
M.	0.00	69570.00	0.00	0.00
C.	99819.00	110910.00	0.00	0.00
O.	0.00	1605.00	0.00	0.00
ALL	230294.00	275281.00	0.00	0.00

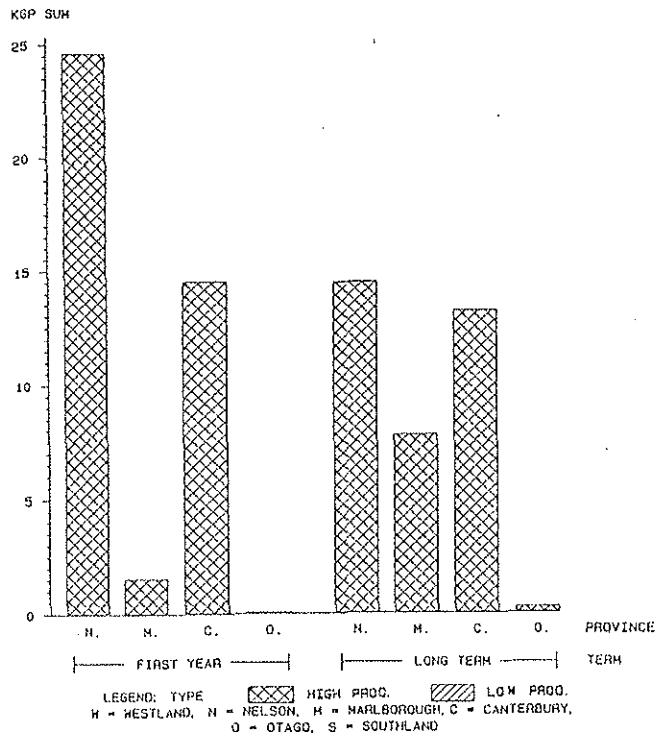
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 21 P MAINTENANCE NEEDS (kg) S.I. MIXED CROPPING AND FINISHING FARMS IN PROVINCES ,FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

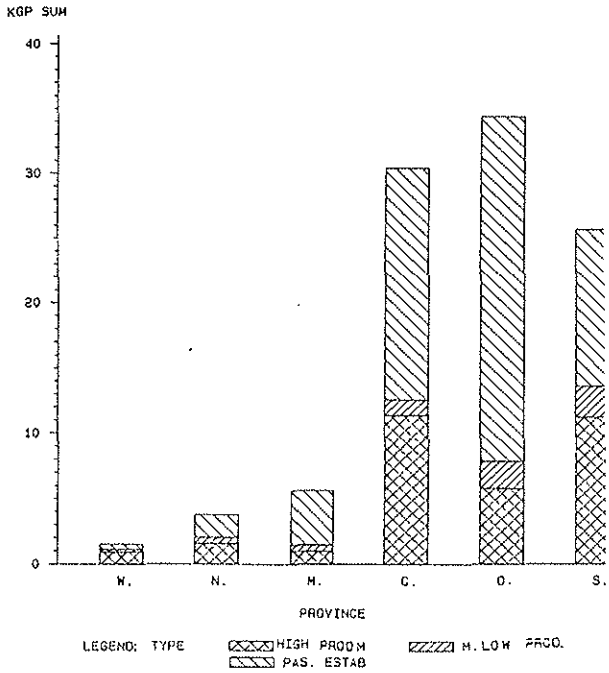
	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
N.	246012.00	144713.00	0.00	0.00
M.	15551.00	77756.00	0.00	0.00
C.	145179.00	131981.00	0.00	0.00
O.	508.00	2542.00	0.00	0.00
ALL	407250.00	356992.00	0.00	0.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 21 P MAINTENANCE NEEDS (KGX10,000) OF S.I. MIXED-CROPPING AND FINISHING FARMS IN PROVINCES, FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT POTENTIAL FARMER STOCKING RATES

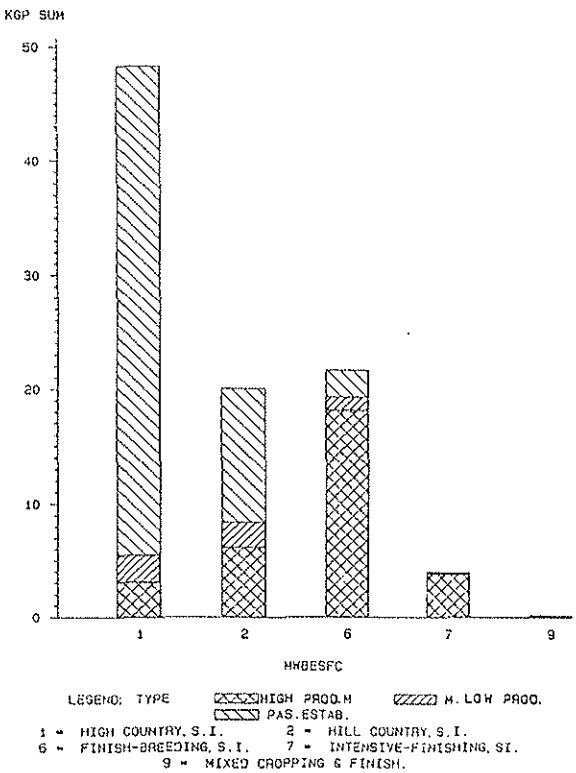


APPENDIX 22: P MAINTENANCE NEEDS (million kg) OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PROD.AND PASTURE ESTABLISHMENT P FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

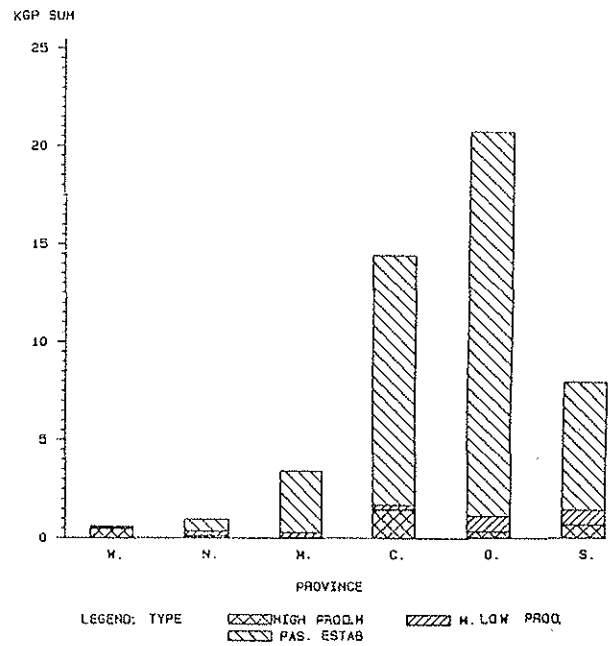


W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND

APPENDIX 23 P MAINTENANCE NEEDS (million kg) OF NHBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PROD.AND PASTURE ESTABLISHMENT P FOR LOW PROD. AT AVERAGE FARMER STOCKING RATES



APPENDIX 24 P MAINTENANCE NEEDS (million kg) OF S.I.HIGH COUNTRY IN PROVINCES, FIRST YEAR FOR LOW PROD AND LONG-TERM FOR HIGH PRODAND PASTURE ESTABLISHMENT P FOR LOW PROD AT AVERAGE FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY, O = OTAGO, S = SOUTHLAND.

APPENDIX 22 P MAINTENANCE NEEDS (kg) OF PROVINCES OF THE SOUTH ISLAND, FIRST YEAR FOR LOW PROD., AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			ALL
	HIGH PROD.M	M.LOW PROD.	PAS. ESTAB	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	931067.00	202124.00	417837.00	1551028.00
N.	1574616.00	490962.00	1738962.00	3804540.00
M.	995785.00	497999.00	4176505.00	5670289.00
C.	11408164.00	1194271.00	17890331.00	30492766.00
O.	5803667.00	2091741.00	26561414.00	34456822.00
S.	11225406.00	2400211.00	12055325.00	25680942.00
ALL	31938705.00	6877308.00	62840374.00	101656387.00

W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 23 P MAINTENANCE NEEDS (kg) OF MWBES FARM CLASSES OF THE SOUTH ISLAND, FIRST YEAR FOR LOW PROD. AND AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			ALL
	HIGH PROD.M	M.LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
1	3094528.00	2427071.00	42770990.00	48292589.00
2	6146599.00	2256154.00	11675350.00	20078103.00
6	18130899.00	1181188.00	2358306.00	21670393.00
7	3731555.00	130893.00	110293.00	3972741.00
9	170300.00	0.00	0.00	170300.00
ALL	31273881.00	5995306.00	56914939.00	94184126.00

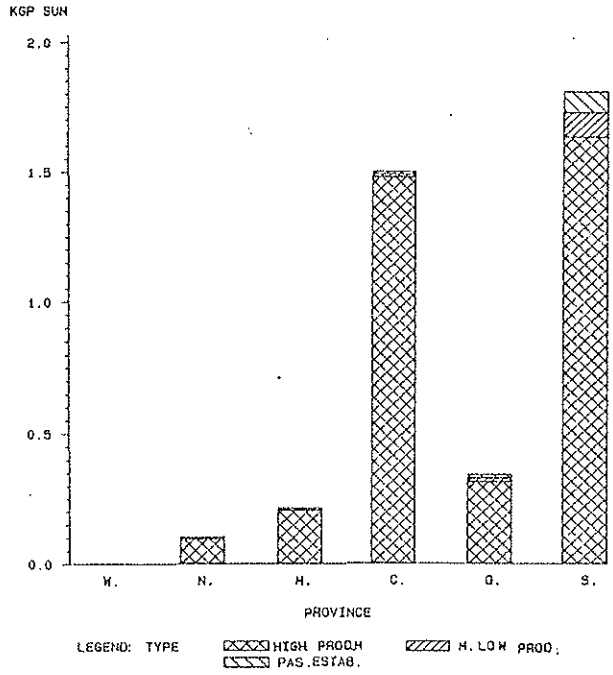
1 = HIGH COUNTRY,S.I. 2 = HILL COUNTRY,S.I.
6 = FINISH-BREEDING,S.I. 7 = INTENSIVE-FINISHING,SI.
9 = MIXED CROPPING & FINISHING FARMS

APPENDIX 24 P MAINTENANCE NEEDS (kg) OF S.I.HIGH COUNTRY IN PROVINCES , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			ALL
	HIGH PROD.M	M. LOW PROD.	PAS. ESTAB	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	480166.00	81199.00	68907.00	630272.00
N.	109376.00	256675.00	602131.00	968182.00
M.	23399.00	284170.00	3128670.00	3436239.00
C.	1467697.00	238634.00	12746810.00	14453141.00
O.	329758.00	803401.00	19662525.00	20795684.00
S.	684132.00	762992.00	6561947.00	8009071.00
ALL	3094528.00	2427071.00	42770990.00	48292589.00

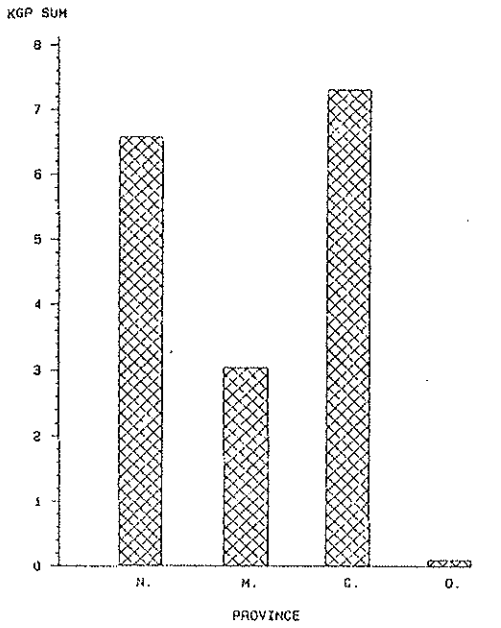
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 27 .P MAINTENANCE NEEDS (million kg) OF
S.I.INTENSIVE-FINISHING FARMS , IN PROVINCES , FIRST YEAR
FOR LOW PROD. AND LONG-TERM FOR HIGH PRO.AND PASTURE
ESTABLISHMENT P FOR LOW PROD. AT AVERAGE FARMER STOCKING RATES



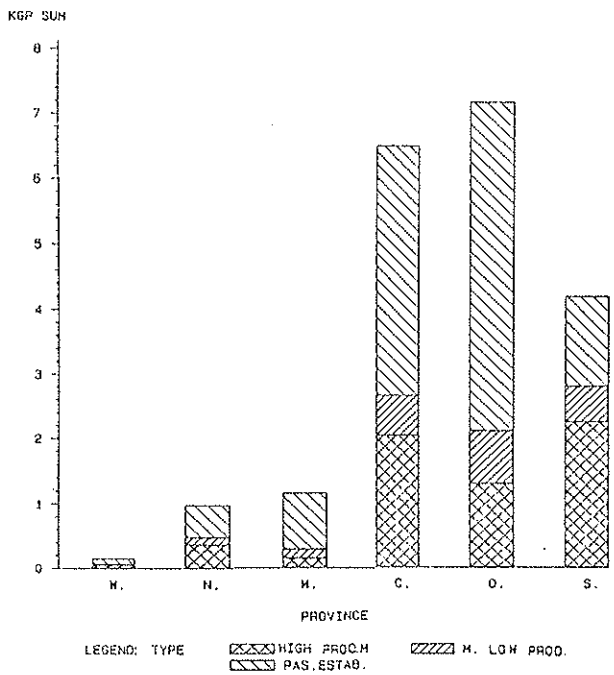
W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY,
O = OTAGO, S = SOUTHLAND.

APPENDIX 28 P MAINTENANCE NEEDS (Kgx10,000) OF
S.I.MIXED-CROPPING FARMS , IN PROVINCES , FIRST YEAR
FOR LOW PROD. AND LONG-TERM FOR HIGH PRO.AND PASTURE
ESTABLISHMENT P FOR LOW PROD. AT AVERAGE FARMER STOCKING RATES



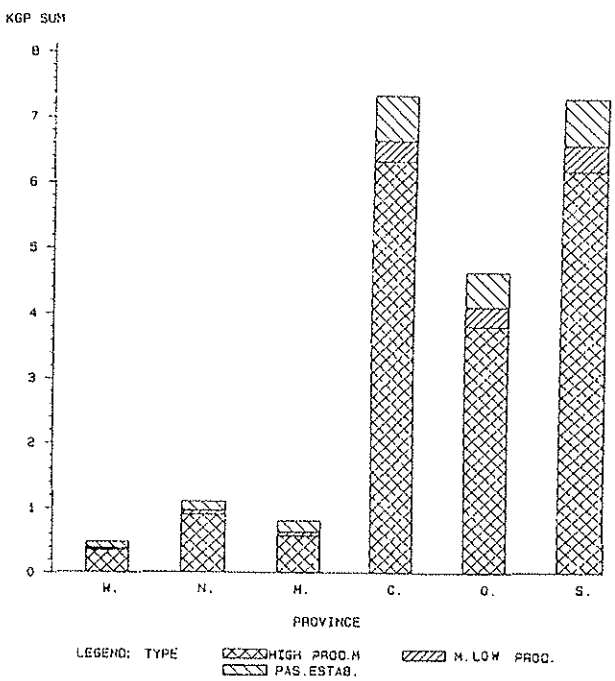
N = NELSON, M = MARLBOROUGH, C = CANTERBURY,
O = OTAGO.

APPENDIX 25 P MAINTENANCE NEEDS (million kg) OF
S.I.HILL COUNTRY , IN PROVINCES , FIRST YEAR
FOR LOW PROD. AND LONG-TERM FOR HIGH PROD AND PASTURE
ESTABLISHMENT P FOR LOW PROD. AT AVERAGE FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY,
O = OTAGO, S = SOUTHLAND.

APPENDIX 26 , P MAINTENANCE NEEDS (million kg) OF
S.I.FINISHING-BREEDING FARMS , FIRST YEAR
FOR LOW PROD. AND LONG-TERM FOR HIGH PROD AND PASTURE
ESTABLISHMENT P FOR LOW PROD. AT AVERAGE FARMER STOCKING RATES



W = WESTLAND, N = NELSON, M = MARLBOROUGH, C = CANTERBURY,
O = OTAGO, S = SOUTHLAND.

APPENDIX 25 P MAINTENANCE NEEDS (kg) OF S.I.HILL COUNTRY IN PROVINCES , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			ALL
	HIGH PROD.M	M. LOW PROD.	PAS.ESTAB.	
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	57456.00	0.00	92592.00	150048.00
N.	364892.00	116875.00	494664.00	976431.00
M.	149225.00	143975.00	867197.00	1160397.00
C.	2028392.00	623856.00	3811973.00	6464221.00
O.	1295880.00	817325.00	5033219.00	7146424.00
S.	2250754.00	554123.00	1375706.00	4180583.00
ALL	6146599.00	2256154.00	11675351.00	20078104.00

APPENDIX 26 P MAINTENANCE NEEDS (kg) OF S.I. FINISHING-BREEDING FARMS IN PROVINCES , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			ALL
	HIGH PROD.M	M. LOW PROD.	PAS.ESTAB.	
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	345754.00	34075.00	94398.00	474227.00
N.	895686.00	65224.00	140331.00	1101241.00
M.	567372.00	66125.00	171397.00	804894.00
C.	6333063.00	316813.00	695702.00	7345578.00
O.	3813894.00	298459.00	526081.00	4638434.00
S.	6175131.00	400491.00	730398.00	7306020.00
ALL	18130900.00	1181187.00	2358307.00	21670394.00

APPENDIX 27 P MAINTENANCE NEEDS (kg) OF S.I. INTENSIVE-FINISHING FARMS IN PROVINCES , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

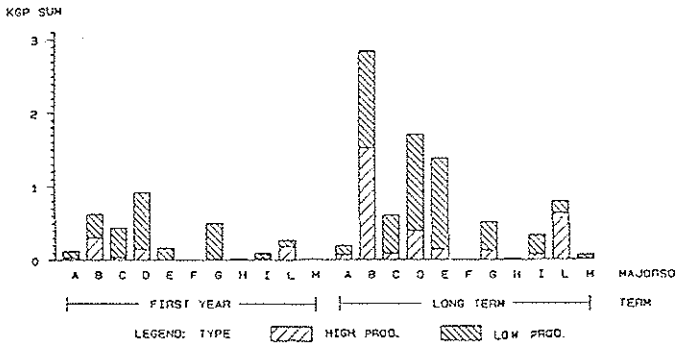
	TYPE			ALL
	HIGH PROD.M	M.LOW PROD.	PAS.ESTAB.	
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
W.	1687.00	0.00	0.00	1687.00
N.	96185.00	3493.00	3315.00	102993.00
M.	204791.00	3716.00	6830.00	215337.00
C.	1478353.00	12457.00	7906.00	1498716.00
O.	316192.00	14751.00	12293.00	343236.00
S.	1634348.00	96475.00	79950.00	1810773.00
ALL	3731556.00	130892.00	110294.00	3972742.00

APPENDIX 28 P MAINTENANCE NEEDS (kg) OF S.I. MIXED-CROPPING FARMS IN PROVINCES , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AND PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			ALL
	HIGH PROD.M	M.LOW PROD.	PAS.ESTAB.	
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
N.	65688.00	0.00	0.00	65688.00
M.	30405.00	0.00	0.00	30405.00
C.	73242.00	0.00	0.00	73242.00
O.	965.00	0.00	0.00	965.00
ALL	170300.00	0.00	0.00	170300.00

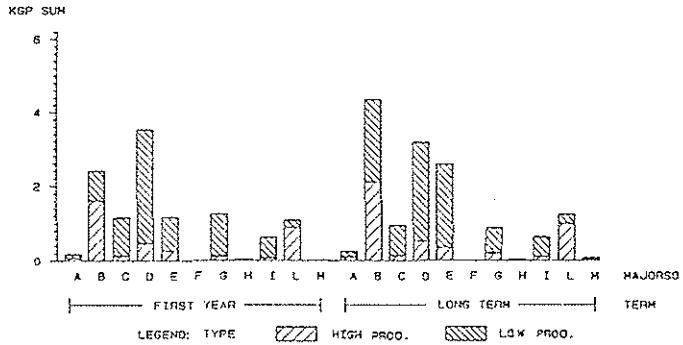
W. = WESTLAND N. = NELSON M. = MARLBOROUGH C. = CANTERBURY
O. = OTAGO S. = SOUTHLAND

APPENDIX 29 P MAINTENANCE NEEDS (million Kg)
OF S.I. HIGH COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT AVERAGE FARMER STOCKING RATES



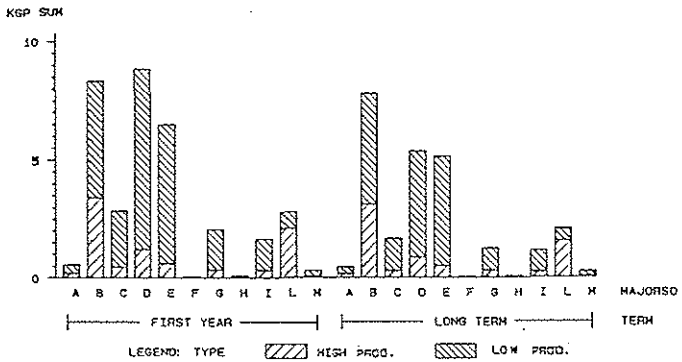
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 30 P MAINTENANCE NEEDS (million Kg)
OF S.I. HIGH COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT TOP FARMER STOCKING RATES



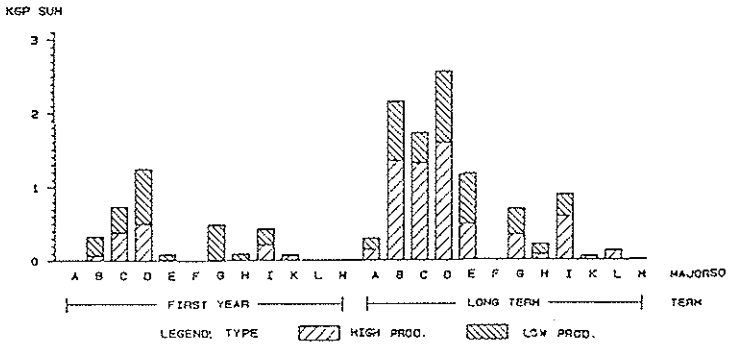
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 31 P MAINTENANCE NEEDS (million Kg)
OF S.I. HIGH COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT POTENTIAL FARMER STOCKING RATES



MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 32 P MAINTENANCE NEEDS (million Kg)
OF S.I. HILL COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT AVERAGE FARMER STOCKING RATES



MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 29 P MAINTENANCE NEEDS (Kg)
OF S.I. HIGH COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MAJORSO				
A	34225.15	77051.72	88410.21	122885.50
B	307794.65	1514380.60	321296.23	1319744.97
C	40370.67	94132.73	402180.88	513711.45
D	156930.05	399781.72	767836.77	1296395.89
E	6851.41	149345.40	163413.53	1225716.82
F	0.00	0.00	3695.04	3886.05
G	14084.05	136447.47	493307.48	379419.88
H	0.00	1900.45	22032.03	25147.42
I	28101.59	71219.26	72781.64	259320.20
L	191629.98	634290.19	84245.52	153833.15
M	4391.76	15978.77	7871.72	51630.97
ALL	784379.32	3094528.31	2427071.05	5351692.30

APPENDIX 30 P MAINTENANCE NEEDS (Kg)
OF S.I. HIGH COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT TOP FARMER STOCKING RATES

MAJORSO				
A	71279.29	106737.55	104748.43	146138.79
B	1621322.65	2095561.01	792637.81	2229569.20
C	134180.77	146978.21	1031955.28	803869.06
D	479937.72	545661.27	3063536.60	2585798.27
E	280522.47	351710.61	897070.79	2195722.99
F	0.00	0.00	3695.04	3886.05
G	129041.16	209653.18	1120571.09	668887.33
H	0.00	2479.18	48832.28	37722.30
I	82457.79	109200.33	550654.11	531066.48
L	895563.59	990259.07	195727.06	246247.37
M	9944.56	20914.51	15811.31	62379.77
ALL	3704250.01	4579154.92	7825239.79	9511287.61

APPENDIX 31 P MAINTENANCE NEEDS (Kg)
OF S.I. HIGH COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT POTENTIAL FARMER STOCKING RATES

MAJORSO				
A	202643.42	169805.62	353644.86	288476.65
B	3416140.13	3122840.47	4925780.24	4679101.50
C	450538.50	294332.89	2410648.20	1371969.15
D	1204010.71	865177.02	7636319.95	4480974.06
E	613474.82	494213.80	5870669.60	4636206.92
F	0.00	0.00	23896.92	12358.80
G	334370.80	304628.31	1719816.44	937508.43
H	0.00	4664.22	87680.98	54331.28
I	320765.33	230411.21	1325973.77	914232.61
L	2086342.53	1558934.75	723744.33	516792.25
M	46584.69	47351.75	268157.64	206168.11
ALL	8674870.91	7092360.04	25346332.93	18098119.76

MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 32 P MAINTENANCE NEEDS (Kg)
OF S.I. HILL COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MAJORSO				
A	0.00	147771.58	5424.06	155028.47
B	72440.47	1353333.07	264235.24	808133.60
C	387317.36	1322161.80	358979.30	413502.77
D	506048.39	1599371.79	745515.62	977222.24
E	11509.06	493280.31	82820.35	685834.22
F	0.00	596.88	0.00	2876.63
G	12305.83	348885.42	488340.67	360989.05
H	0.00	79880.01	93356.32	141369.64
I	215994.55	605059.64	217482.57	296773.84
K	75232.98	57871.52	0.00	0.00
L	0.00	131184.23	0.00	9220.73
M	0.00	7202.67	0.00	12269.70
ALL	1280848.64	6146598.92	2256154.14	3863220.89

APPENDIX 33 P MAINTENANCE NEEDS (Kg)
OF S.I. HILL COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT TOP FARMER STOCKING RATES

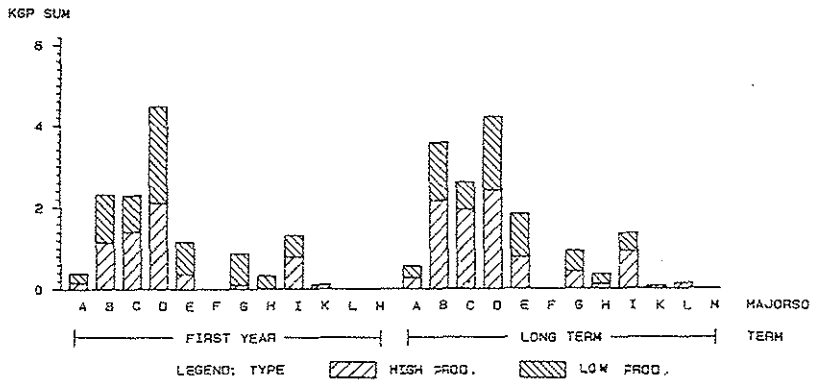
MAJORSO				
A	169235.68	275686.14	233251.84	299732.91
B	1152887.49	2135485.71	1165029.96	1422379.72
C	1408101.48	1925433.62	891045.52	659898.74
D	2101935.17	2392710.16	2367700.99	1806034.14
E	375083.75	766643.89	802197.09	1058704.86
F	813.31	1016.64	2449.82	4899.64
G	106934.64	427511.90	776450.32	500849.77
H	8796.74	124528.11	328705.57	252427.45
I	783872.13	904858.49	532199.35	453111.13
K	113408.88	75605.92	0.00	0.00
L	0.00	134252.45	0.00	9506.75
M	0.00	9969.44	886.26	13815.60
ALL	6221069.28	9173702.47	7099916.70	6481360.71

APPENDIX 34 P MAINTENANCE NEEDS (Kg)
OF S.I. HILL COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT POTENTIAL FARMER STOCKING RATES

MAJORSO				
A	395990.32	388971.76	447243.51	408551.59
B	3530127.71	3308878.31	3839039.84	2652706.98
C	3500329.07	2825538.21	1707155.03	1011299.28
D	4953707.98	3631011.35	4748927.81	2782769.44
E	1434205.27	1209483.18	2609227.82	1838702.27
F	2874.96	1916.64	12008.28	9237.14
G	876673.33	775002.31	1621797.65	874895.74
H	110879.32	188950.26	608819.99	371113.07
I	1475177.40	1234372.58	930399.36	632751.23
K	181201.23	106588.96	0.00	0.00
L	421951.63	421951.63	33899.68	28249.73
M	12828.62	16035.77	27400.30	30444.78
ALL	16895946.83	14108700.96	16585919.27	10640721.25

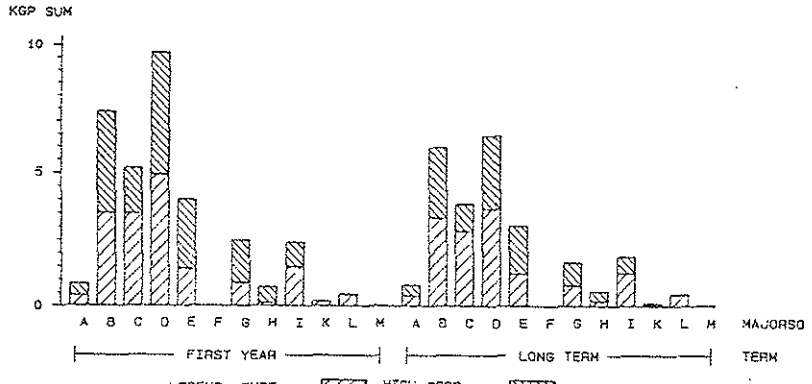
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 33 P MAINTENANCE NEEDS (million Kg)
OF S.I. HILL COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT TOP FARMER STOCKING RATES



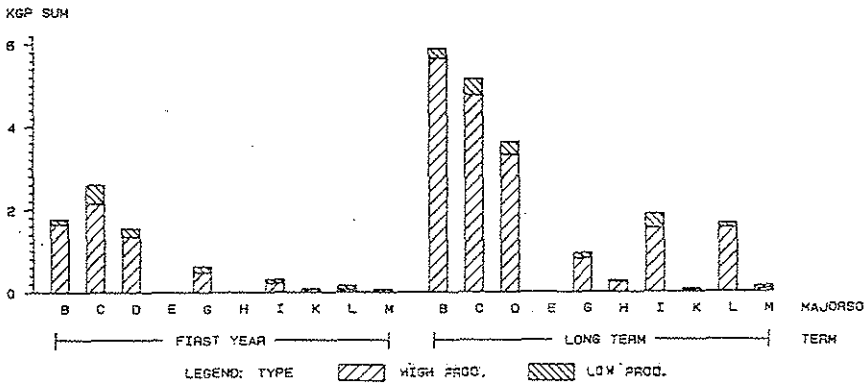
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 34 P MAINTENANCE NEEDS (million Kg)
OF S.I. HILL COUNTRY FOR MAJOR SOIL GROUPS, FIRST YEAR
AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT POTENTIAL FARMER STOCKING RATES



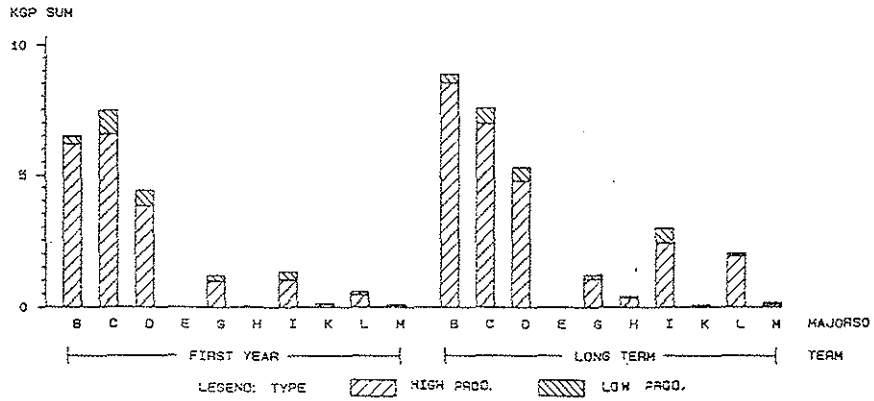
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 35 P MAINTENANCE NEEDS (million Kg)
OF S.I. FINISHING-BREEDING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT AVERAGE FARMER STOCKING RATES



MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 36 P MAINTENANCE NEEDS (million Kg)
OF S.I. FINISHING-BREEDING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT TOP FARMER STOCKING RATES



MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 35 P MAINTENANCE NEEDS (Kg)
OF S.I. FINISHING-BREEDING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
MAJORSO	SUM	SUM	SUM	SUM
B	1650874.61	5666704.91	122978.40	235206.65
C	2153457.14	4777219.68	454626.17	401718.08
D	1360883.63	3314470.91	195329.30	319038.67
E	0.00	17552.10	0.00	1648.20
G	493618.51	827946.46	142135.14	114783.02
H	0.00	257766.43	8921.35	31472.73
I	236252.61	1556924.36	87768.14	334880.37
K	81721.33	68101.11	6115.56	4704.28
L	75503.96	1566845.48	92146.00	100346.01
M	650.99	77367.45	71168.21	75214.18
ALL	6052962.78	18130898.89	1181188.28	1619012.19

APPENDIX 36 P MAINTENANCE NEEDS (Kg)
OF S.I. FINISHING-BREEDING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT TOP FARMER STOCKING RATES

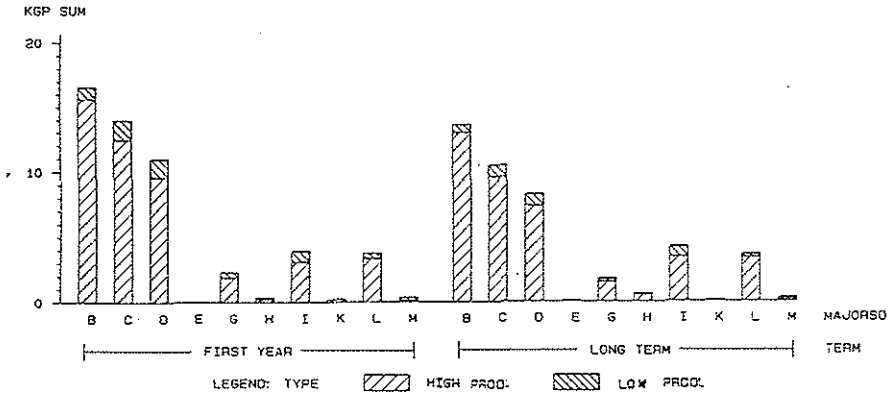
MAJORSO				
B	6204773.69	8537568.09	303453.58	336196.05
C	6589749.85	6970498.97	903815.09	606025.22
D	3829835.64	4762669.08	602115.24	540191.16
E	0.00	17552.10	0.00	1648.20
G	999208.36	1083131.18	233361.40	157454.03
H	14462.60	370625.74	50465.70	51346.53
I	1060064.77	2424216.08	318858.97	554746.61
K	133455.47	88970.31	9833.41	6145.88
L	471773.67	1931103.60	121137.54	110498.14
M	650.99	98727.65	115669.86	97006.34
ALL	19303975.05	26285062.80	2658710.79	2461258.16

APPENDIX 37 P MAINTENANCE NEEDS (Kg)
OF S.I. FINISHING-BREEDING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT POTENTIAL FARMER STOCKING RATES

MAJORSO				
B	15627135.85	12852869.51	946494.63	625168.75
C	12440723.60	9492527.32	1523752.19	858563.00
D	9578892.57	7287508.48	1388480.85	872428.47
E	86019.56	78199.60	11014.80	7343.20
G	1900952.35	1521898.18	422928.94	243382.63
H	258680.14	536902.66	127698.35	84057.75
I	3095883.57	3384201.87	838955.03	787109.72
K	213231.05	125430.03	14729.55	8664.44
L	3333246.67	3349942.97	411883.87	235101.39
M	116003.56	165603.12	262931.11	154665.36
ALL	46650768.92	38795083.74	5948869.31	3876484.71

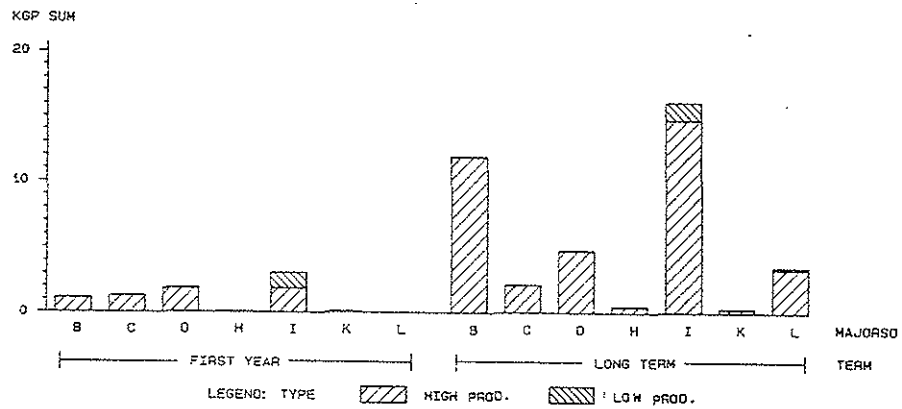
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 37 P MAINTENANCE NEEDS (million Kg)
OF S.I. FINISHING-BREEDING FARMS FOR MAJOR SOIL GROUPS.
FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT POTENTIAL FARMER STOCKING RATES



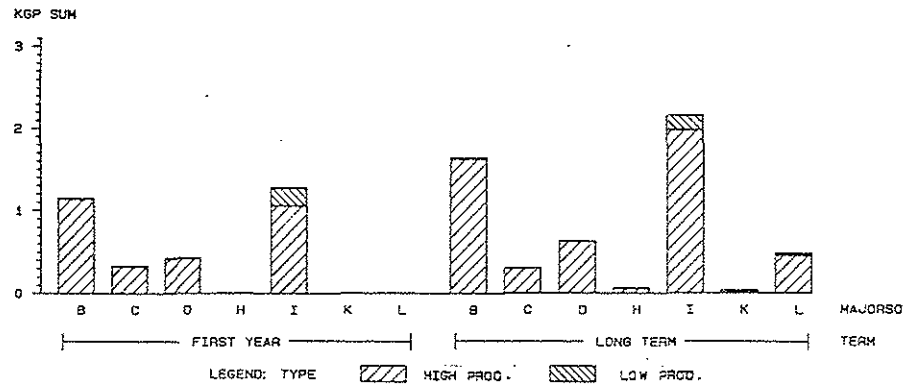
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 38 P MAINTENANCE NEEDS (Kgx100,000)
OF S.I. INTENSIVE - FINISHING FARMS FOR MAJOR SOIL GROUPS.
FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT AVERAGE FARMER STOCKING RATES



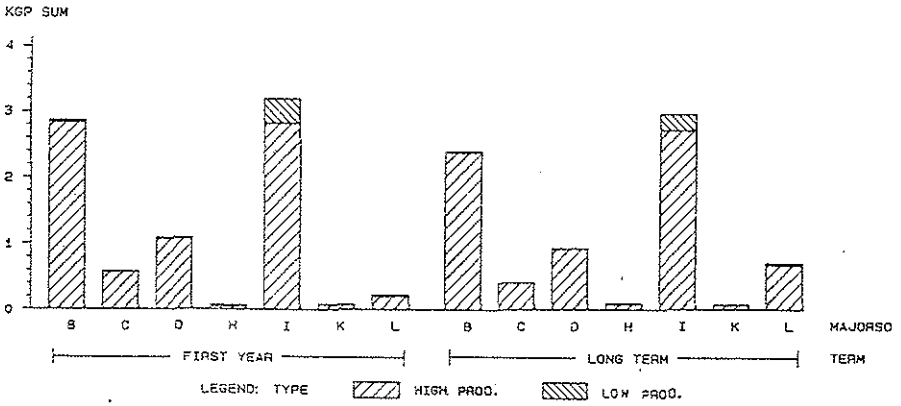
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 39 P MAINTENANCE NEEDS (million Kg)
OF S.I. INTENSIVE- FINISHING FARMS FOR MAJOR SOIL GROUPS.
FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT TOP FARMER STOCKING RATES



MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 40 P MAINTENANCE NEEDS (million Kg)
OF S.I. INTENSIVE-FINISHING FARMS FOR MAJOR SOIL GROUPS.
FIRST YEAR AND LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES
AT POTENTIAL FARMER STOCKING RATES



MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 38 P MAINTENANCE NEEDS (Kg)
OF S.I. INTENSIVE - FINISHING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT AVERAGE FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MAJORSO				
B	111681.43	1169485.17	2042.75	8662.96
C	127246.28	214285.80	0.00	0.00
D	182739.60	472130.10	3716.40	3097.00
H	0.00	46996.34	5746.22	7493.62
I	186172.49	1459847.28	119387.33	135287.76
K	9630.38	32101.25	0.00	2592.50
L	0.00	336709.19	0.00	16780.50
ALL	617470.17	3731555.13	130892.70	173914.34

APPENDIX 39 P MAINTENANCE NEEDS (Kg)
OF S.I. INTENSIVE - FINISHING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT TOP FARMER STOCKING RATES

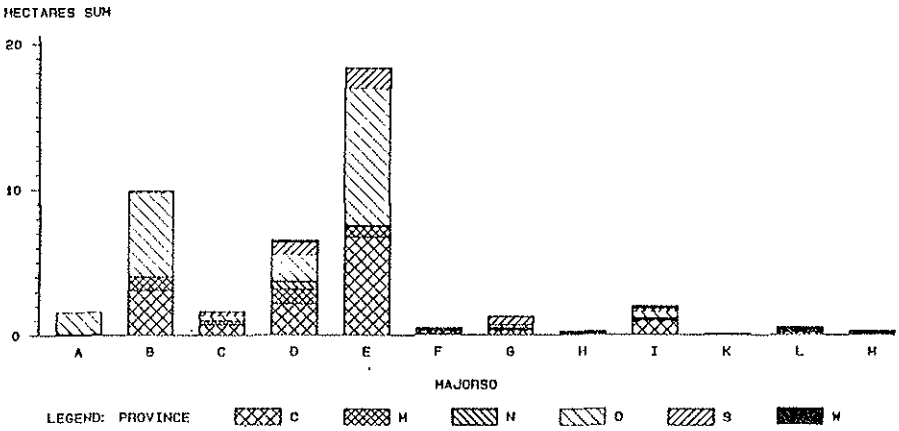
	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MAJORSO				
B	1140262.61	1627025.31	7805.83	11975.34
C	333716.49	310007.04	0.00	0.00
D	428212.08	632265.08	7210.88	4506.80
H	0.00	60385.62	8742.19	8971.28
I	1059780.80	1975244.25	216472.47	182467.13
K	10148.21	33827.35	0.00	2731.90
L	0.00	463136.85	6641.65	23008.28
ALL	2972120.19	5101891.50	246873.02	233660.73

APPENDIX 40 P MAINTENANCE NEEDS (Kg)
OF S.I. INTENSIVE - FINISHING FARMS FOR MAJOR SOIL GROUPS,
FIRST YEAR AND LONG-TERM FOR LOW PROD. AND HIGH PRODUCING
PASTURES AT POTENTIAL FARMER STOCKING RATES

	TYPE			
	HIGH PRODUCING		LOW PRODUCING	
	TERM		TERM	
	FIRST YEAR	LONG TERM	FIRST YEAR	LONG TERM
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MAJORSO				
B	2841569.26	2367974.38	22813.47	18326.92
C	576057.81	415308.46	0.00	0.00
D	1077564.97	920456.92	14887.64	7835.60
H	49039.43	85531.44	21736.68	14491.12
I	2818684.55	2715661.82	376218.62	251145.03
K	82878.06	69065.05	3346.62	5577.70
L	202880.84	676269.48	25820.50	32275.63
ALL	7648674.92	7250267.55	464823.53	329652.00

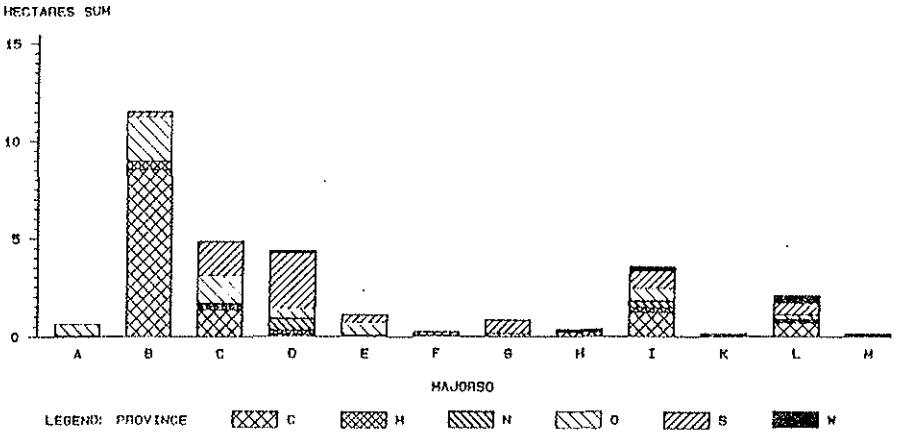
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 41a AREA HECTARES (X100000) IN PROVINCES
OF LOW PROD. S.ISLAND SOILS, IN GRASSLAND WHERE P1 PASTURE IS NOT PRESENT



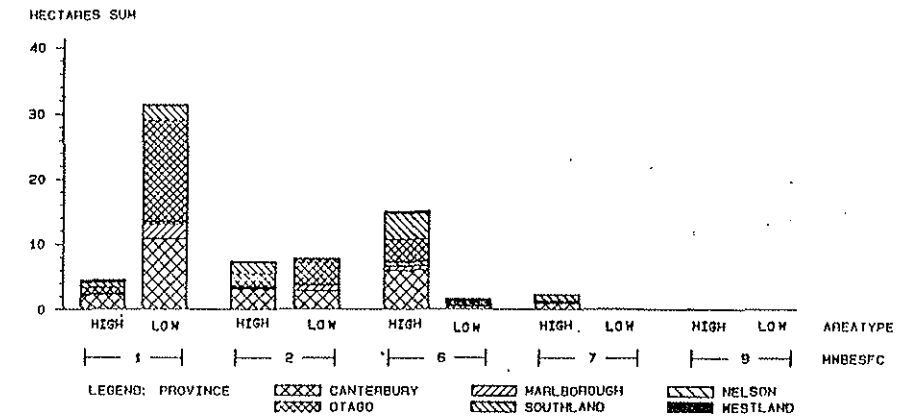
PROVINCES C=CANTERBURY, H=MARLBOROUGH, N=NELSON, O=OTAGO, S=SOUTHLAND, W=WESTLAND
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 41b AREA HECTARES (X100000) IN PROVINCES
OF HIGH PRO.S.ISLAND SOILS, IN GRASSLAND WHERE P1 PASTURE IS PRESENT



PROVINCES C=CANTERBURY, H=MARLBOROUGH, N=NELSON, O=OTAGO, S=SOUTHLAND, W=WESTLAND
MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 42 AREA HECTARES (X100,000) IN PROVINCES OF UNIMPROVED
LOW AND HIGH SOUTH ISLAND PRODUCING GRASSLAND, OF
MWBES FARM CLASSES OF THE SOUTH ISLAND



1 = HIGH COUNTRY, S.I. 2 = HILL COUNTRY, S.I.
6 = FINISH-BREEDING, S.I. 7 = INTENSIVE-FINISHING, SI.
9 = MIXED CROPPING & FINISH.

APPENDIX 41a AREA HECTARES IN PROVINCES
OF LOW PROD. S.ISLAND SOILS, IN GRASSLAND WHERE P1 PASTURE IS NOT PRESENT

	C	M	N	O	S	W	ALL
	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES
	SUM	SUM	SUM	SUM	SUM	SUM	SUM
MAJORSO							
A	12102.00	.	.	146081.00	.	.	158183.00
B	310880.00	90607.00	.	574343.00	13962.00	.	989792.00
C	75616.00	25055.00	242.00	34942.00	26615.00	0.00	162470.00
D	214575.00	101429.00	52534.00	184786.00	83621.00	9849.00	646794.00
E	675770.00	70673.00	3822.00	939843.00	141472.00	105.00	1831685.00
F	.	67.00	10879.00	12427.00	13546.00	8440.00	45359.00
G	33227.00	9216.00	7639.00	21909.00	57162.00	0.00	129153.00
H	6076.00	12194.00	4881.00	1561.00	1408.00	.	26120.00
I	100501.00	6417.00	7026.00	46262.00	22723.00	13881.00	196810.00
K	212.00	.	22.00	6544.00	6659.00	0.00	13437.00
L	17051.00	1840.00	1285.00	7947.00	11989.00	8748.00	48860.00
M	7347.00	2624.00	2850.00	3095.00	9068.00	2935.00	27919.00
ALL	1453357.00	320122.00	91180.00	1979740.00	388225.00	43958.00	4276582.00

APPENDIX 41b AREA HECTARES IN PROVINCES
OF HIGH PROD. S.ISLAND SOILS, IN GRASSLAND WHERE P1 PASTURE IS PRESENT

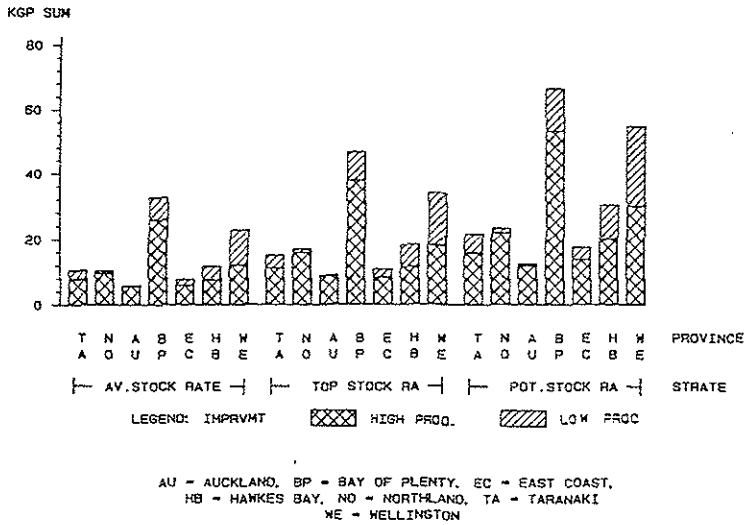
	C	M	N	O	S	W	ALL
	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES
	SUM	SUM	SUM	SUM	SUM	SUM	SUM
MAJORSO							
A	7157.00	.	.	56462.00	.	.	63619.00
B	852691.00	43722.00	.	228349.00	28210.00	.	1152972.00
C	137108.00	15853.00	12616.00	145805.00	176585.00	342.00	488309.00
D	10954.00	20431.00	58417.00	51213.00	284546.00	8397.00	433958.00
E	9494.00	335.00	0.00	63656.00	38690.00	0.00	112175.00
F	.	0.00	1804.00	3116.00	20997.00	95.00	26012.00
G	1401.00	0.00	520.00	13487.00	70739.00	427.00	86574.00
H	24145.00	1167.00	1906.00	6014.00	4405.00	.	37637.00
I	124024.00	20865.00	32867.00	65883.00	90630.00	17097.00	351366.00
K	5677.00	.	74.00	2350.00	8947.00	158.00	17206.00
L	70492.00	8581.00	6073.00	25664.00	59942.00	33847.00	204599.00
M	4494.00	824.00	4495.00	180.00	2037.00	1159.00	13189.00
ALL	1247637.00	111778.00	118772.00	662179.00	785728.00	61522.00	2987616.00

MAJOR SOIL GROUPS A=BROWN GREY EARTHS, B=YELLOW GREY EARTHS
C=YELLOW GREY EARTHS-YELLOW BROWN EARTHS, D=LOWLAND YELLOW
BROWN EARTHS, E=UPLAND AND HIGH COUNTRY YELLOW BROWN EARTHS,
F=UPLAND AND HIGH COUNTRY PODSOLISED YELLOW BROWN EARTHS,
G=BROWN GRANULAR LOAMS AND INTERGRADES, H=RENDZINAS,
I=RECENT ALLUVIA, K=PEATS, L=GLEYS, M=YELLOW BROWN SANDS

APPENDIX 42 AREA (HECTARES) IN PROVINCES OF LOW AND HIGH PRODUCING
PASTURES OF SOUTH ISLAND SOILS IN GRASSLAND, OF MAFBES FARM CLASSES
OF THE SOUTH ISLAND

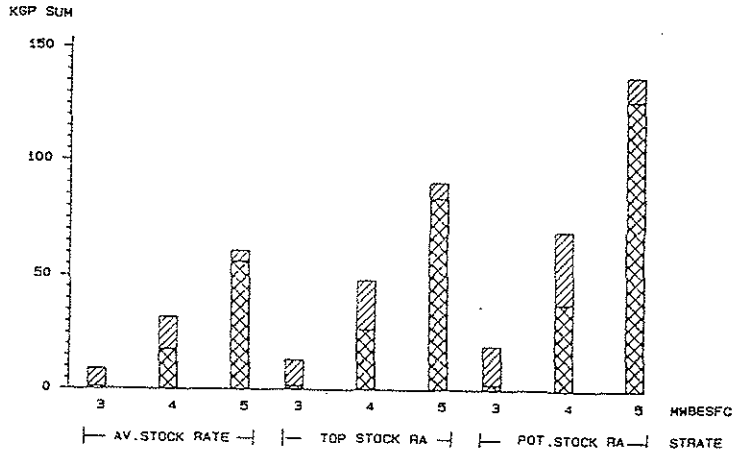
	MAFBESFC								MAFBESFC	
	1		2		6		7		9	
	AREATYPE		AREATYPE		AREATYPE		AREATYPE		AREATYPE	
	HIGH PROD.	LOW PROD.	HIGH PROD.	LOW PROD.	HIGH PROD.	LOW PROD.	HIGH PROD.	LOW PROD.	HIGH PROD.	LOW PROD.
	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM
PROVINCE										
CANTERBURY	227694.00	1081387.00	307677.00	290147.00	604102.00	44534.00	96104.00	2198.00	7216.00	0.00
MARLBOROUGH	5928.00	225125.00	22774.00	79817.00	64983.00	12706.00	13296.00	610.00	2293.00	0.00
NELSON	11273.00	38799.00	24478.00	18414.00	68548.00	12556.00	6794.00	442.00	4168.00	0.00
OTAGO	98365.00	1551716.00	200610.00	335915.00	335037.00	40424.00	20928.00	1251.00	139.00	0.00
SOUTHLAND	75054.00	230959.00	170258.00	43699.00	398035.00	26593.00	91805.00	6150.00	.	.
WESTLAND	31188.00	5149.00	3928.00	5787.00	23142.00	10990.00	211.00	0.00	.	.
ALL	449502.00	3133135.00	729725.00	773779.00	1493847.00	155803.00	229138.00	10651.00	13816.00	0.00

APPENDIX 43 P MAINTENANCE NEEDS, (million kg) ,OF PROVINCES
OF THE NORTH ISLAND, LONG-TERM FOR LOW AND HIGH PRODUCING
PASTURES AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



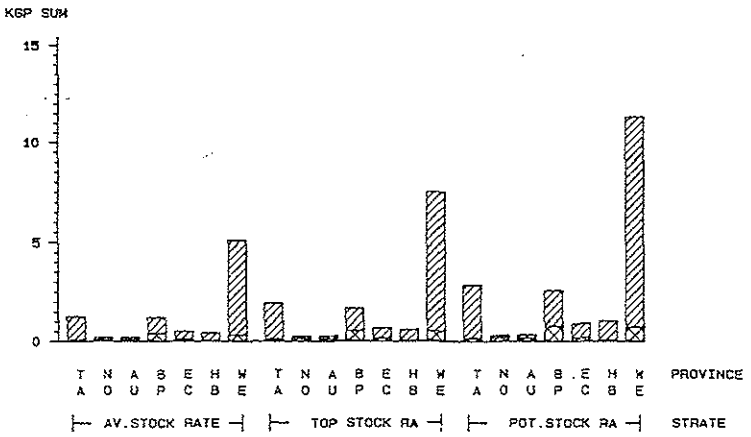
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 44 P MAINTENANCE NEEDS (million kg) OF
MMBES FARM CLASSES OF THE NORTH ISLAND, LONG-TERM FOR LOW AND HIGH PRODUCING
PASTURES AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



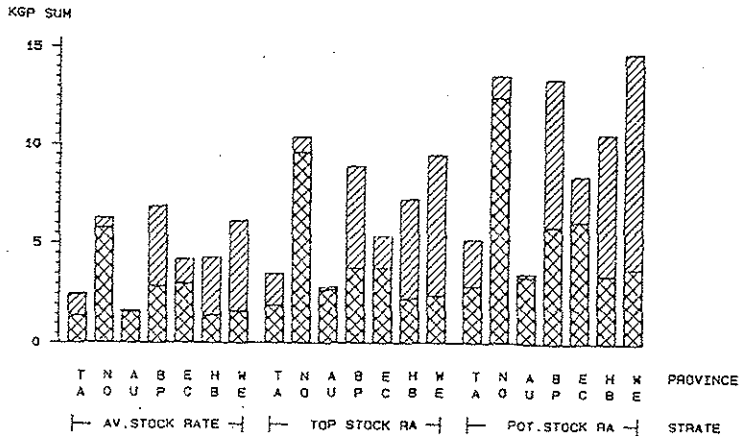
MEAT AND WOOL BOARD ECONOMIC FARM CLASSES OF THE NORTH ISLAND,
3 = HARD HILL COUNTRY, 4 = EASIER HILL,
5 = INTENSIVE FINISHING FARMS

APPENDIX 45 P MAINTENANCE NEEDS (million kg) OF
HARD HILL COUNTRY OF THE NORTH ISLAND, IN PROVINCES,
LONG-TERM FOR LOW AND HIGH PRODUCING AT AVERAGE, TOP AND
POTENTIAL FARMER STOCKING RATES



AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 46 P MAINTENANCE NEEDS (million kg) OF
EASIER HILL COUNTRY OF THE NORTH ISLAND, IN PROVINCES,
LONG-TERM FOR LOW AND HIGH PRODUCING AT AVERAGE, TOP AND
POTENTIAL FARMER STOCKING RATES



AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 43 P MAINTENANCE NEEDS (kg) OF PROVINCES OF THE NORTH ISLAND , LONG-TERM FOR LOW PROD. AND HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	5688224.33	201461.11	5889685.44
BP	25796054.80	6799058.33	32595113.13
EC	5995461.50	1807187.50	7802649.00
HB	7672092.64	4064683.65	11736776.29
NO	9704133.79	661216.35	10365350.14
TA	7958457.70	2604205.64	10562663.34
WE	12204761.32	10524849.44	22729610.76
ALL	75019186.08	26662662.02	101681848.10

STRATE TOP STOCK RA

	STRATE		
	TOP STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	8751816.45	290368.49	9042184.94
BP	37666998.24	8987140.73	46654138.97
EC	8379688.27	2475311.46	10854999.73
HB	11511214.18	6678634.74	18189848.92
NO	15941879.82	990681.57	16932561.39
TA	11201404.24	3871142.11	15072546.35
WE	18098114.59	15781187.07	33879301.66
ALL	111551115.79	39074466.17	150625581.96

STRATE POT.STOCK RA

	STRATE		
	POT.STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	11991237.08	393007.90	12384244.98
BP	53245410.95	13180720.81	66426131.76
EC	13831860.56	3624162.65	17456023.21
HB	19964544.56	10206546.03	30171090.59
NO	21794429.41	1365743.90	23160173.31
TA	15955300.10	5623037.93	21578338.03
WE	29891149.29	24724734.08	54615883.37
ALL	166673931.95	59117953.30	225791885.25

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 44 P MAINTENANCE NEEDS (kg) OF MWBES FARM CLASSES OF THE NORTH ISLAND ,LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
MWBESFC			
3	1211883.71	7768948.07	8980831.78
4	17790825.19	14134650.10	31925475.29
5	56016477.18	4759063.85	60775541.03
ALL	75019186.08	26662662.02	101681848.10

STRATE TOP STOCK RA

	STRATE		
	TOP STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
MWBESFC			
3	1711468.26	11260287.53	12971755.79
4	26675094.54	21115296.08	47790390.62
5	83164552.99	6698882.56	89863435.55
ALL	111551115.79	39074466.17	150625581.96

STRATE POT.STOCK RA

	STRATE		
	POT.STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
MWBESFC			
3	2384247.35	17033102.60	19417349.95
4	37983897.99	31405040.49	69388938.48
5	126305786.61	10679810.21	136985596.82
ALL	166673931.95	59117953.30	225791885.25

MEAT AND WOOL BOARD ECONOMIC FARM CLASSES OF THE NORTH ISLAND,
3 = HARD HILL COUNTRY, 4 = EASIER HILL,
5 = INTENSIVE FINISHING FARMS

APPENDIX 45 P MAINTENANCE NEEDS (kg) OF HARD HILL COUNTRY OF THE NORTH ISLAND ,IN PROVINCES, LONG-TERM FOR LOW PROD. AND HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	105002.29	101515.23	206517.52
BP	416976.43	812322.69	1229299.12
EC	121496.25	403868.45	525364.70
HB	35114.18	405359.72	440473.90
NO	94142.63	96384.29	190526.92
TA	90448.19	1191836.55	1282284.74
WE	348703.74	4757661.14	5106364.88
ALL	1211883.71	7768948.07	8980831.78

STRATE TOP STOCK RA

	STRATE		
	TOP STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	136056.88	134717.75	270774.63
BP	547507.73	1129212.41	1676720.14
EC	166708.80	531593.81	698302.61
HB	46726.13	573998.25	620724.38
NO	159080.23	106162.92	265243.15
TA	122706.30	1831581.41	1954287.71
WE	532682.19	6953020.98	7485703.17
ALL	1711468.26	11260287.53	12971755.79

STRATE POT.STOCK RA

	STRATE		
	POT.STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	161177.89	183588.70	344766.59
BP	808857.42	1780544.92	2589402.34
EC	199774.96	724393.56	924168.52
HB	70274.41	988353.18	1058627.59
NO	214170.37	118158.83	332329.20
TA	173760.05	2680100.91	2853860.96
WE	756232.25	10557962.50	11314194.75
ALL	2384247.35	17033102.60	19417349.95

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 46 P MAINTENANCE NEEDS (kg) OF EASIER HILL COUNTRY OF THE NORTH ISLAND ,IN PROVINCES, LONG-TERM FOR LOW PROD. AND HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	1596688.14	79892.10	1676580.24
BP	2904922.25	3964810.98	6869733.23
EC	3020365.63	1182856.37	4203222.00
HB	1434093.84	2862126.33	4296220.17
NO	5753444.45	498383.93	6251828.38
TA	1426377.54	1064403.81	2490781.35
WE	1654933.34	4482176.58	6137109.92
ALL	17790825.19	14134650.10	31925475.29

STRATE TOP STOCK RA

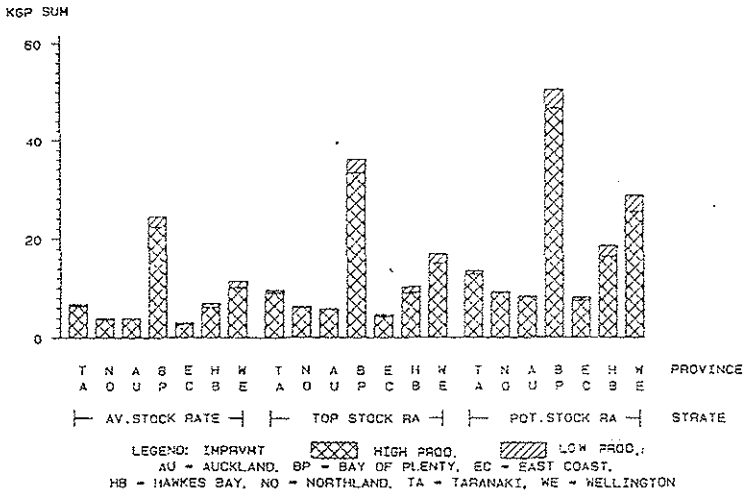
	STRATE		
	TOP STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	2741843.69	128736.15	2870579.84
BP	3815672.18	5088940.70	8904612.88
EC	3806408.53	1574109.67	5380518.20
HB	2300068.03	4946960.24	7247028.27
NO	9621447.34	773786.98	10395234.32
TA	1945835.83	1563029.67	3508865.50
WE	2443818.94	7039732.67	9483551.61
ALL	26675094.54	21115296.08	47790390.62

STRATE POT.STOCK RA

	STRATE		
	POT.STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	3393956.07	170160.92	3564116.99
BP	5874472.53	7536026.93	13410499.46
EC	6110122.09	2294463.40	8404585.49
HB	3458112.69	7104521.63	10562634.32
NO	12433068.21	1093104.08	13526172.29
TA	2915812.08	2299082.83	5214894.91
WE	3798354.32	10907680.70	14706035.02
ALL	37983897.99	31405040.49	69388938.48

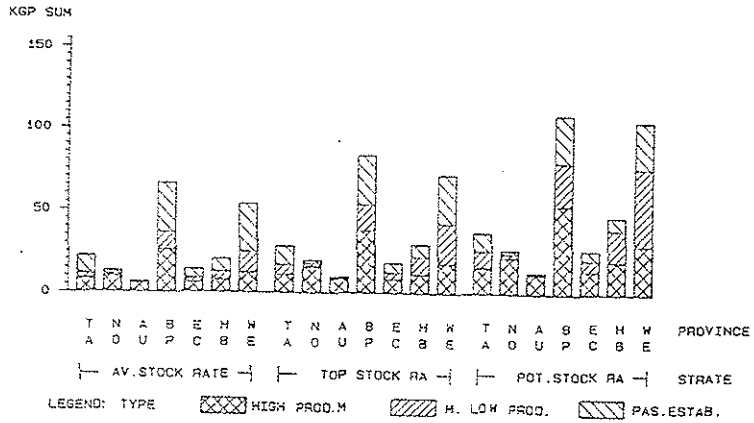
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 47 P MAINTENANCE NEEDS (million kg) OF INTENSIVE-FINISHING FARMS OF THE NORTH ISLAND. IN PROVINCES. LONG-TERM FOR LOW AND HIGH PROD. PAST. AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



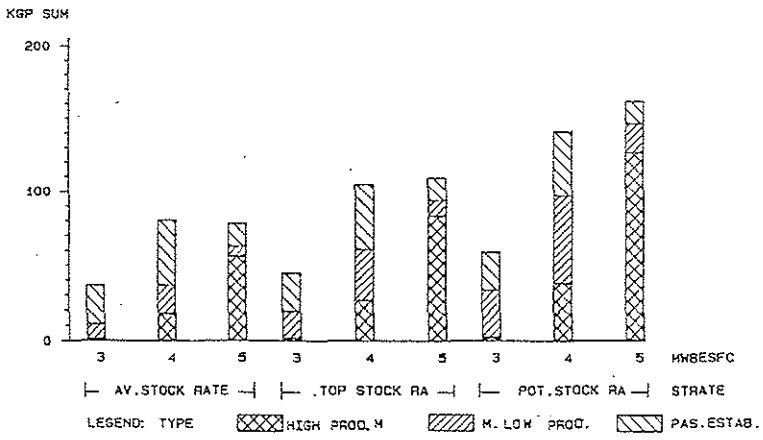
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 48 P MAINTENANCE NEEDS (million kg) OF PROVINCES OF THE NORTH ISLAND, FIRST YEAR FOR LOW PROD AND LONG-TERM FOR HIGH PRODUCING PASTURES AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES



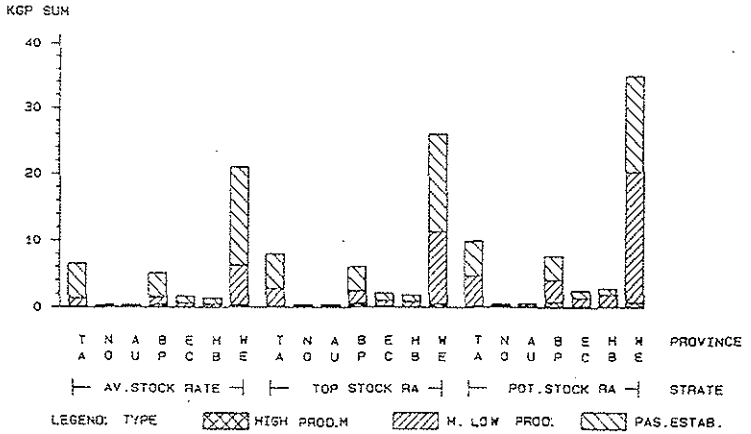
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 49 P MAINTENANCE NEEDS (million kg) OF HWBES FARM CLASSES OF THE NORTH ISLAND, FIRST YEAR FOR LOW PRODUCING PASTURES AND LONG-TERM FOR HIGH PRO. AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES



MEAT AND WOOL BOARD ECONOMIC FARM CLASSES OF THE NORTH ISLAND.
3 = HARD HILL COUNTRY, 4 = EASIER HILL,
5 = INTENSIVE FINISHING FARMS

APPENDIX 50 P MAINTENANCE NEEDS (million kg) OF HARD HILL COUNTRY OF THE NORTH ISLAND, FIRST YEAR FOR LOW PRODUCING PASTURES AND LONG-TERM FOR HIGH PRO. AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES



AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 47 P MAINTENANCE NEEDS (kg) OF INTENSIVE-FINISHING FARMS OF THE NORTH ISLAND ,IN PROVINCES, LONG-TERM FOR LOW PROD, AND HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	3986533.90	20053.78	4006587.68
BP	22474156.12	2021924.66	24496080.78
EC	2853599.62	220462.68	3074062.30
HB	6202884.62	797197.60	7000082.22
NO	3856546.71	66448.13	3922994.84
TA	6441631.97	347965.28	6789597.25
WE	10201124.24	1285011.72	11486135.96
ALL	56016477.18	4759063.85	60775541.03

STRATE TOP STOCK RA

	STRATE		
	TOP STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	5073915.88	26914.59	5900830.47
BP	33303818.33	2768987.62	36072805.95
EC	4406570.94	369607.98	4776178.92
HB	9164420.02	1157676.25	10322096.27
NO	6161352.25	110731.67	6272083.92
TA	9132862.11	476531.03	9609393.14
WE	15121613.46	1788433.42	16910046.88
ALL	83164552.99	6698882.56	89863435.55

STRATE POT.STOCK RA

	STRATE		
	POT.STOCK RA		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
PROVINCE			
AU	8436103.12	39258.28	8475361.40
BP	46562081.00	3864148.96	50426229.96
EC	7521963.51	605305.69	8127269.20
HB	16436157.46	2113671.22	18549828.68
NO	9147190.83	154480.99	9301671.82
TA	12865727.97	643854.19	13509582.16
WE	25336562.72	3259090.88	28595653.60
ALL	126305786.61	10679810.21	136985596.82

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 48 P MAINTENANCE NEEDS (kg) OF PROVINCES OF THE NORTH ISLAND , FIRST YEAR FOR LOW PROD. AND LONG-TERM HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES

STRATE AV.STOCK RATE

	STRATE			
	AV.STOCK RATE			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	5688224.33	283475.65	336208.50	6307908.48
BP	25796054.80	10535380.83	29457364.00	65788799.63
EC	5995461.50	2404718.42	5845765.50	14245945.42
HB	7672092.64	4705549.66	7638946.00	20016588.30
NO	9704133.79	958440.04	2016001.00	12678574.83
TA	7958457.70	3008601.93	11145853.00	22112912.63
WE	12204761.32	12442659.21	28731560.00	53378980.53
ALL	75019186.08	34338825.74	85171698.00	194529709.82

STRATE TOP STOCK RA

	STRATE			
	TOP STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	8751816.45	484863.08	336208.50	9572888.03
BP	37666998.24	15481279.80	29457364.00	82605642.04
EC	8379688.27	3866071.13	5845765.50	18091524.90
HB	11511214.18	10403590.01	7638946.00	29553750.19
NO	15941879.82	1670972.64	2016001.00	19628853.46
TA	11201404.24	5789579.15	11145853.00	28136836.39
WE	18098114.59	23980283.54	28731560.00	70809958.13
ALL	111551115.79	61676639.34	85171698.00	258399453.13

STRATE POT.STOCK RA

	STRATE			
	POT.STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	11991237.08	718891.50	336208.50	13046337.08
BP	53245410.95	25255892.53	29457364.00	107958667.48
EC	13831060.56	6606721.09	5845765.50	26284347.15
HB	19964544.56	18941451.89	7638946.00	46544942.45
NO	21794429.41	2543425.44	2016001.00	26353855.85
TA	15955300.10	9691614.06	11145853.00	36792767.16
WE	29891149.29	45400011.46	28731560.00	104022720.75
ALL	166673931.95	109158007.97	85171698.00	361003637.92

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 49 P MAINTENANCE NEEDS (kg) OF MWBES FARM CLASSES OF THE NORTH ISLAND , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES

STRATE AV.STOCK RATE

	STRATE			
	AV.STOCK RATE			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
3	1211883.71	9375249.67	25817987.00	36405120.38
4	17790825.19	18466947.42	44016567.50	80274340.11
5	56016477.18	6496628.65	15337143.50	77850249.33
ALL	75019186.08	34338825.74	85171698.00	194529709.82

STRATE TOP STOCK RA

	STRATE			
	TOP STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
3	1711468.26	17203867.25	25817987.00	44733322.51
4	26675094.54	33917040.30	44016567.50	104608702.35
5	83164552.99	10555731.79	15337143.50	109057428.28
ALL	111551115.79	61676639.34	85171698.00	258399453.13

STRATE POT.STOCK RA

	STRATE			
	POT.STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
MWBESFC				
3	2384247.35	30749336.30	25817987.00	58951570.65
4	37983897.99	58741942.67	44016567.50	140742408.16
5	126305786.61	19666729.00	15337143.50	161309659.11
ALL	166673931.95	109158007.97	85171698.00	361003637.92

MEAT AND WOOL BOARD ECONOMIC FARM CLASSES OF THE NORTH ISLAND,
3 = HARD HILL COUNTRY, 4 = EASIER HILL,
5 = INTENSIVE FINISHING FARMS

APPENDIX 50 P MAINTENANCE NEEDS (kg) OF HARD HILL COUNTRY OF THE NORTH ISLAND , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES

STRATE AV.STOCK RATE

	STRATE			
	AV.STOCK RATE			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	105002.29	151563.79	123137.00	379703.08
BP	416976.43	1095304.72	3567947.00	5080228.15
EC	121496.25	512864.39	1074888.00	1709248.64
HB	35114.18	447073.09	942779.00	1424966.27
NO	94142.63	156157.67	133000.50	383300.80
TA	90448.19	1242188.92	5192642.50	6525279.61
WE	348703.74	5770097.10	14783593.00	20902393.84
ALL	1211883.71	9375249.67	25817987.00	36405120.38

STRATE TOP STOCK RA

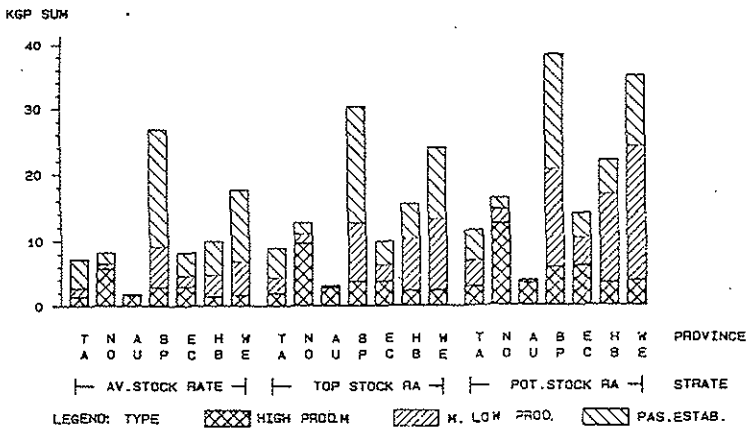
	STRATE			
	TOP STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	136056.88	229291.72	123137.00	488485.60
BP	547507.73	1812250.35	3567947.00	5927705.08
EC	166708.80	820294.90	1074888.00	2061891.70
HB	46726.13	818547.92	942779.00	1808053.05
NO	159080.23	178005.35	133000.50	470086.08
TA	122706.30	2610744.94	5192642.50	7926093.74
WE	532682.19	10734732.05	14783593.00	26051007.24
ALL	1711468.26	17203867.25	25817987.00	44733322.51

STRATE POT.STOCK RA

	STRATE			
	POT.STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	161177.89	339443.82	123137.00	623758.71
BP	808857.42	3267654.12	3567947.00	7644458.54
EC	199774.96	1245559.45	1074888.00	2520222.41
HB	70274.41	1764900.95	942779.00	2777954.36
NO	214170.37	205715.18	133000.50	552886.05
TA	173760.05	4530857.47	5192642.50	9897260.02
WE	756232.25	19395205.32	14783593.00	34935030.57
ALL	2384247.35	30749336.30	25817987.00	58951570.65

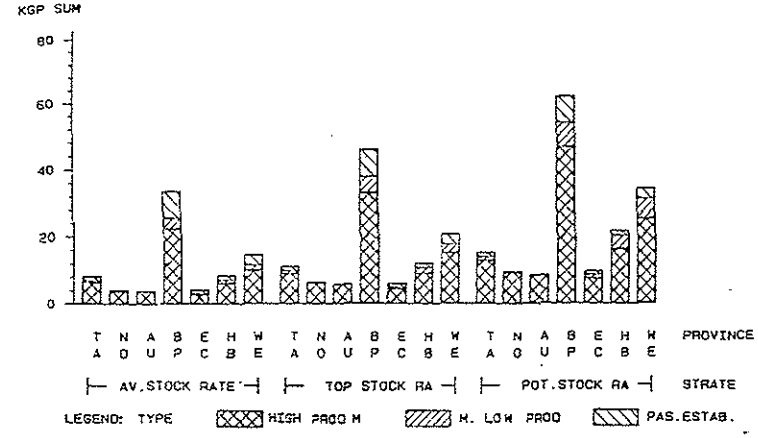
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 51 P MAINTENANCE NEEDS (million kg) OF EASIER HILL COUNTRY OF THE NORTH ISLAND, FIRST YEAR FOR LOW PRODUCING PASTURES AND LONG-TERM FOR HIGH PRO AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES



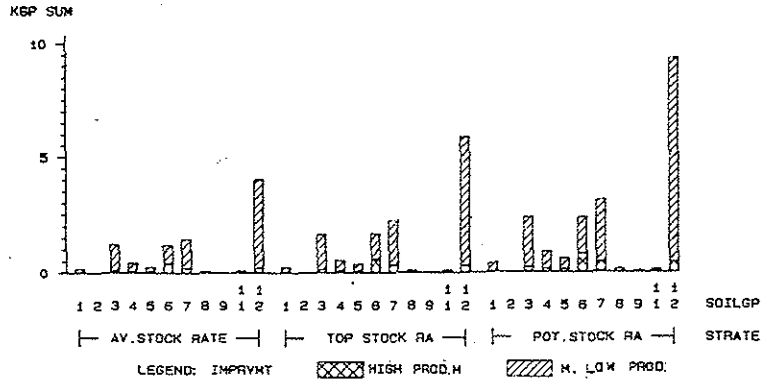
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 52 P MAINTENANCE NEEDS (million kg) OF INTENSIVE FINISHING FARMS OF THE NORTH ISLAND, FIRST YEAR FOR LOW PRODUCING PASTURES AND LONG-TERM FOR HIGH PRO AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES



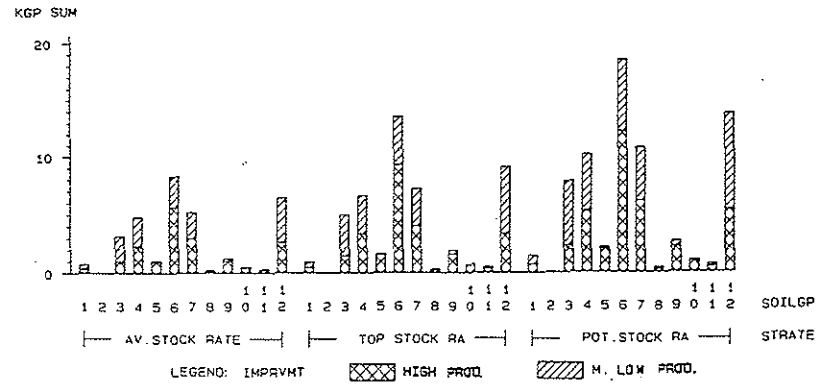
AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 53 P MAINTENANCE NEEDS (million kg) OF HARD HILL COUNTRY OF THE NORTH ISLAND, FOR MAJOR SOIL GROUPS, LONG-TERM FOR LOW PROD AND HIGH PRO AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BRONN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 54 P MAINTENANCE NEEDS (million kg) OF EASIER HILL COUNTRY OF THE NORTH ISLAND, FOR MAJOR SOIL GROUPS, LONG-TERM FOR LOW PROD AND HIGH PROD AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 51 P MAINTENANCE NEEDS (kg) OF EASIER HILL COUNTRY OF THE NORTH ISLAND , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P LOW PRODUCING PASTURES

STRATE AV.STOCK RATE

	STRATE			
	AV.STOCK RATE			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	1596688.14	104940.50	175048.50	1876677.14
BP	2904922.25	6256128.81	17690349.00	26851400.06
EC	3020365.63	1633768.52	3669303.00	8323437.15
HB	1434093.84	3317507.52	5240855.50	9992456.86
NO	5753444.45	740407.45	1758084.50	8251936.39
TA	1426377.54	1260062.77	4623114.50	7309554.81
WE	1654933.34	5154131.85	10859812.50	17668877.69
ALL	17790825.19	18466947.42	44016567.50	80274340.11

STRATE TOP STOCK RA

	STRATE			
	TOP STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	2741843.69	213128.83	175048.50	3130021.01
BP	3815672.18	8830781.91	17690349.00	30336803.09
EC	3806408.53	2470126.60	3669303.00	9945838.13
HB	2300068.03	7946415.08	5240855.50	15487338.61
NO	9621447.34	1349579.33	1758084.50	12729111.17
TA	1945835.83	2385292.40	4623114.50	8954242.73
WE	2443818.94	10721716.15	10859812.50	24025347.59
ALL	26675094.54	33917040.30	44016567.50	104608702.34

STRATE POT.STOCK RA

	STRATE			
	POT.STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	3393956.07	311083.40	175048.50	3880087.97
BP	5874472.53	14673802.46	17690349.00	38238623.99
EC	6110122.09	4221468.17	3669303.00	14000893.26
HB	3458112.69	13270924.54	5240855.50	21969892.73
NO	12433068.21	2096799.73	1758084.50	16287952.44
TA	2915812.08	4010394.07	4623114.50	11549320.65
WE	3798354.32	20157470.29	10859812.50	34815637.11
ALL	37983897.99	58741942.67	44016567.50	140742408.16

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 52 P MAINTENANCE NEEDS (kg) OF INTENSIVE FINISHING FARMS OF THE NORTH ISLAND , FIRST YEAR FOR LOW PROD. AND LONG-TERM FOR HIGH PRODUCING AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES WITH PASTURE ESTABLISHMENT P FOR LOW PRODUCING PASTURES

STRATE AV.STOCK RATE

	STRATE			
	AV.STOCK RATE			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	3986533.90	26971.36	38023.00	4051528.26
BP	22474156.12	3183947.31	8199068.00	33857171.43
EC	2853599.62	258085.51	1101574.50	4213259.63
HB	6202884.62	940969.04	1455311.50	8599165.16
NO	3856546.71	61874.92	124916.00	4043337.63
TA	6441631.97	506350.24	1330096.00	8278078.21
WE	10201124.24	1518430.27	3088154.50	14807709.00
ALL	56016477.18	6496628.65	15337143.50	77850249.33

STRATE TOP STOCK RA

	STRATE			
	TOP STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	5873915.88	42442.53	38023.00	5954381.41
BP	33303818.33	4838247.54	8199068.00	46341133.87
EC	4406570.94	575649.62	1101574.50	6083795.06
HB	9164420.02	1638627.00	1455311.50	12258358.52
NO	6161352.25	143387.96	124916.00	6429656.21
TA	9132862.11	793541.81	1330096.00	11256499.91
WE	15121613.46	2523835.33	3088154.50	20733603.29
ALL	83164552.99	10555731.79	15337143.50	109057428.28

STRATE POT.STOCK RA

	STRATE			
	POT.STOCK RA			
	TYPE			
	HIGH PROD.	LOW PROD.	PAS.ESTAB.	ALL
	KGP	KGP	KGP	KGP
	SUM	SUM	SUM	SUM
PROVINCE				
AU	8436103.12	68364.28	38023.00	8542490.40
BP	46562081.00	7314435.95	8199068.00	62075584.95
EC	7521963.51	1139693.47	1101574.50	9763231.48
HB	16436157.46	3905626.40	1455311.50	21797095.36
NO	9147190.83	240910.54	124916.00	9513017.37
TA	12865727.97	1150362.51	1330096.00	15346186.48
WE	25336562.72	5847335.85	3088154.50	34272053.07
ALL	126305786.61	19666729.00	15337143.50	161309659.11

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON

APPENDIX 53 P MAINTENANCE NEEDS (kg) OF HARD HILL COUNTRY OF THE NORTH ISLAND FOR MAJOR SOIL GROUPS,LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
SOILGP			
1	23422.74	144867.94	168290.68
2	0.00	87.30	87.30
3	111670.44	1115462.06	1227132.50
4	71791.78	369555.13	441346.91
5	72991.70	179329.99	252321.69
6	451098.39	753038.73	1204137.12
7	235985.46	1238642.58	1474628.04
8	0.00	66993.67	66993.67
9	0.00	22905.88	22905.88
11	14532.71	84905.68	99438.39
12	230390.49	3793159.11	4023549.60
ALL	1211883.71	7768948.07	8980831.78

STRATE TOP STOCK RA

SOILGP			
1	40141.54	222700.45	262841.99
2	0.00	151.65	151.65
3	151169.27	1511488.38	1662657.65
4	99775.10	456844.50	556619.60
5	98975.87	290450.40	389426.27
6	624467.21	1075149.59	1699616.80
7	352292.96	1926943.68	2279236.64
8	0.00	103943.16	103943.16
9	0.00	35386.69	35386.69
11	14532.71	86977.02	101509.73
12	330113.60	5550252.01	5880365.61
ALL	1711468.26	11260287.53	12971755.79

STRATE POT.STOCK RA

SOILGP			
1	69726.99	345883.89	415610.88
2	0.00	250.38	250.38
3	214475.63	2161399.97	2375875.60
4	155598.86	749106.92	904705.78
5	147950.89	468209.30	616160.19
6	835117.25	1538676.79	2373794.04
7	474960.10	2638383.09	3113343.19
8	0.00	148083.27	148083.27
9	0.00	50593.12	50593.12
11	14532.71	99783.82	114316.53
12	471884.92	8832732.05	9304616.97
ALL	2384247.35	17033102.60	19417349.95

MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS, 3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES, 5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL, 7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS, 9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS 11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 54 P MAINTENANCE NEEDS (kg) OF EASIER HILL COUNTRY OF THE NORTH ISLAND FOR MAJOR SOIL GROUPS,LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE , TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
	SUM	SUM	SUM
SOILGP			
1	354889.43	375746.97	730636.40
2	14557.27	0.00	14557.27
3	985520.38	2157696.59	3143216.97
4	2322889.72	2470809.18	4793698.90
5	991015.10	55657.56	1046672.66
6	5675084.32	2622986.18	8298070.50
7	2964324.97	2224401.50	5188726.47
8	164522.56	66496.28	231018.84
9	1015920.07	222149.45	1238069.52
10	453549.96	25752.90	479302.86
11	229993.34	88344.61	318337.95
12	2618558.07	3824608.88	6443166.95
ALL	17790825.19	14134650.10	31925475.29

STRATE TOP STOCK RA

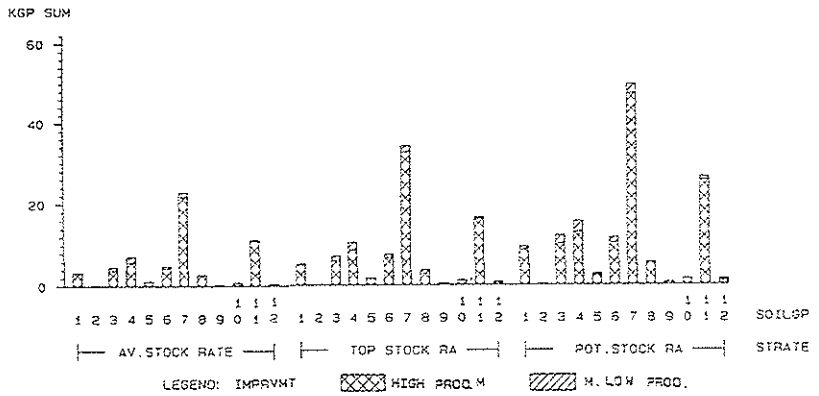
SOILGP			
1	465068.72	480626.62	945695.34
2	17774.69	0.00	17774.69
3	1498006.21	3529353.28	5027359.49
4	3417020.86	3260268.01	6677288.87
5	1568559.33	84809.60	1653368.93
6	9342537.38	4249689.20	13592226.58
7	4065594.38	3207855.12	7273449.50
8	214211.58	96694.61	310906.19
9	1621804.41	318503.28	1940307.69
10	697358.01	28430.09	725788.10
11	367835.65	149319.27	517154.92
12	3399323.32	5709747.00	9109070.32
ALL	26675094.54	21115296.08	47790390.62

STRATE POT.STOCK RATE

SOILGP			
1	738577.14	745126.77	1483703.91
2	31188.43	0.00	31188.43
3	2364357.28	5476871.92	7841229.20
4	5244557.18	4888252.75	10132809.93
5	2005293.23	158687.45	2163980.68
6	12228080.75	6237139.74	18465220.49
7	6117968.56	4644923.62	10762892.18
8	260712.56	142690.59	403403.15
9	2209541.84	469919.10	2679460.94
10	955913.92	33112.01	989025.93
11	496280.26	201690.17	697970.43
12	5331426.84	8406626.37	13738053.21
ALL	37983897.99	31405040.49	69388938.48

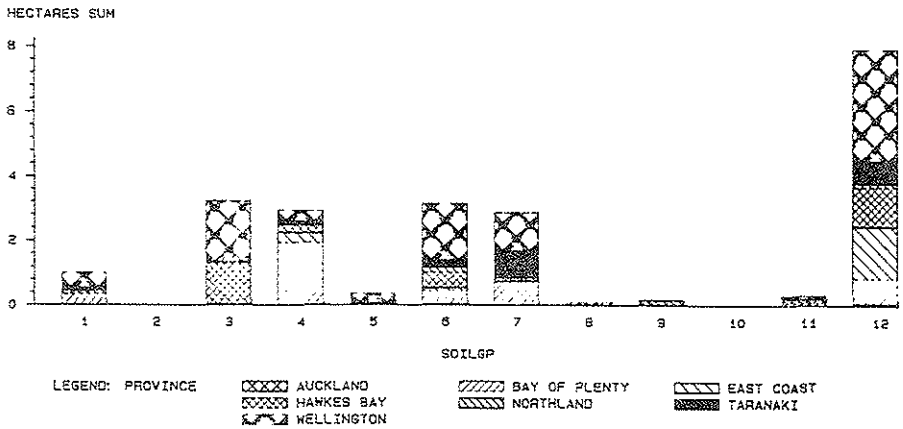
MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS, 3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES, 5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL, 7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS, 9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS 11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 55 P MAINTENANCE NEEDS (million kg) OF INTENSIVE FINISHING FARMS OF THE NORTH ISLAND, FOR MAJOR SOIL GROUPS, LONG-TERM FOR LOW PROD. AND HIGH PROD.AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES



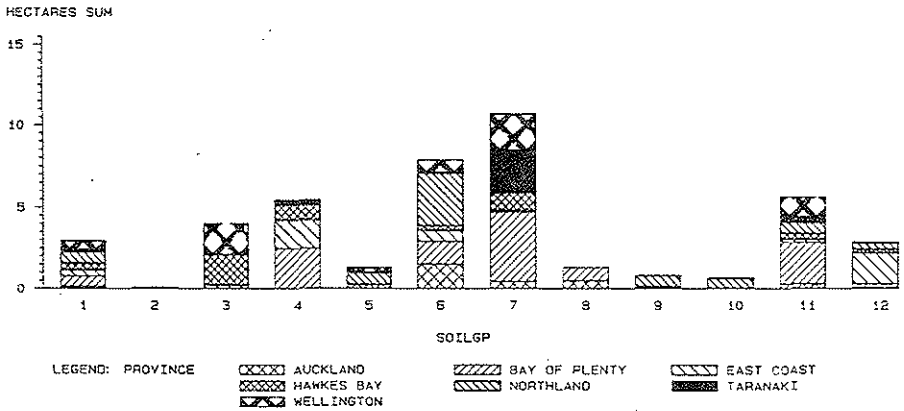
MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 56a AREA HECTARES (X100,000) IN PROVINCES OF LOW PROD. NORTH ISLAND SOILS IN GRASSLAND, WHERE NO P1 HIGH PROD.PASTURE IS PRESENT



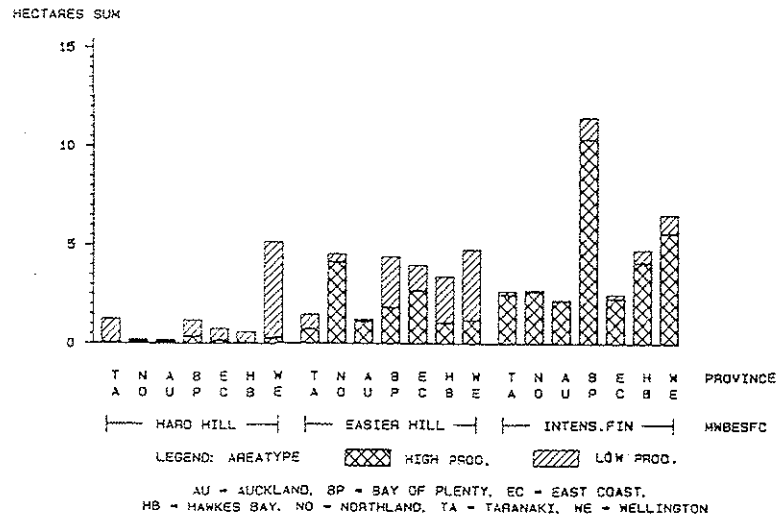
MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 56b AREA HECTARES (X100,000) IN PROVINCES OF NORTH ISLAND LOW PROD.GRASSLAND, WHERE P1 HIGH PROD.PASTURE IS PRESENT



MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 57 AREA HECTARES (X100,000) IN PROVINCES OF LOW AND HIGH PRODUCING NORTH ISLAND SOILS IN GRASSLAND, IN PROVINCES OF MWBES FARM CLASSES



AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI, WE = WELLINGTON

APPENDIX 55 P MAINTENANCE NEEDS (kg) OF INTENSIVE-FINISHING FARMS OF THE NORTH ISLAND FOR MAJOR SOIL GROUPS, LONG-TERM FOR LOW AND HIGH PRODUCING PASTURES AT AVERAGE, TOP AND POTENTIAL FARMER STOCKING RATES

STRATE AV.STOCK RATE

	STRATE		
	AV.STOCK RATE		
	IMPRVMT		
	HIGH PROD.	LOW PROD.	ALL
	KGP	KGP	KGP
SOILGP	SUM	SUM	SUM
1	3240611.01	256194.48	3496805.49
2	119639.77	0.00	119639.77
3	3992331.25	752022.10	4744353.35
4	5957185.43	1373504.83	7330690.26
5	1072436.81	160515.82	1232952.63
6	4423106.37	563272.96	4986379.33
7	21824689.88	1090035.58	22914725.46
8	2829051.97	27324.74	2856376.71
9	287549.34	32410.31	319959.65
10	842271.76	8340.08	850611.84
11	11022880.43	321521.65	11344402.08
12	404723.16	173921.30	578644.46
ALL	56016477.18	4759063.85	60775541.03

STRATE TOP STOCK RA

SOILGP			
1	4990285.61	362593.55	5352879.16
2	188206.68	0.00	188206.68
3	6169631.25	1074122.12	7243753.37
4	8749215.04	1916685.12	10665900.16
5	1646863.80	215033.49	1861897.29
6	6824089.61	797643.04	7621732.65
7	32369979.84	1547729.58	33917709.42
8	3832952.66	39779.31	3872731.97
9	407327.95	49763.31	457091.26
10	1222483.81	10346.24	1232830.05
11	16156872.16	424768.99	16581641.15
12	606644.58	260417.81	867062.39
ALL	83164552.99	6698882.56	89863435.55

STRATE POT.STOCK RA

SOILGP			
1	8761099.18	676778.54	9437877.72
2	298509.67	0.00	298509.67
3	10240591.11	1936476.66	12177067.77
4	13039289.27	2573737.97	15613027.24
5	2476446.37	395447.66	2871894.03
6	10342058.06	1370318.48	11712376.54
7	46853619.91	2344984.95	49198604.86
8	5579544.30	60307.00	5639851.30
9	675931.98	68268.06	744200.04
10	1583972.36	12861.30	1596833.66
11	25416170.87	790091.60	26206262.47
12	1038553.53	450537.99	1489091.52
ALL	126305786.61	10679810.21	136985596.82

MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS, 3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES, 5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL, 7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS, 9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS 11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 56a AREA (HECTARES) IN PROVINCES OF LOW PRODUCING PASTURES OF NORTH ISLAND SOILS IN GRASSLAND, WHERE NO HIGH PROD. PASTURE IS PRESENT

	AUCKLAND	BAY OF PLENTY	EAST COAST	HAWKES BAY	NORTHLAND	TARANAKI	WELLINGTON	ALL
	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM
SOILGP								
1	553.00	32553.00	423.00	9107.00	3555.00	7581.00	46836.00	100608.00
2	0.00	0.00	.	9.00	0.00	.	0.00	9.00
3	.	3017.00	606.00	130860.00	.	.	187517.00	322000.00
4	.	193198.00	31848.00	23278.00	.	12200.00	32886.00	293410.00
5	1680.00	1934.00	0.00	167.00	2755.00	1224.00	28812.00	36572.00
6	2754.00	41719.00	9612.00	48914.00	16263.00	21734.00	174372.00	315368.00
7	0.00	71577.00	3234.00	10757.00	0.00	83465.00	117668.00	286701.00
8	1628.00	7403.00	.	.	.	.	.	9031.00
9	590.00	6730.00	.	.	9514.00	.	.	16934.00
10	212.00	0.00	.	.	1538.00	.	.	1750.00
11	811.00	7251.00	0.00	5046.00	3273.00	1394.00	9792.00	32567.00
12	6969.00	77490.00	161033.00	120516.00	9514.00	71205.00	339648.00	786375.00
ALL	15297.00	442872.00	206756.00	348654.00	51412.00	198803.00	937531.00	2201325.00

APPENDIX 56b AREA (HECTARES) IN PROVINCES OF HIGH PRODUCING PASTURES OF NORTH ISLAND SOILS IN GRASSLAND, WHERE HIGH PROD. PASTURE IS PRESENT

	AUCKLAND	BAY OF PLENTY	EAST COAST	HAWKES BAY	NORTHLAND	TARANAKI	WELLINGTON	ALL
	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM
SOILGP								
1	14146.00	63186.00	39383.00	42382.00	66026.00	18288.00	52318.00	295729.00
2	1982.00	492.00	.	1822.00	5467.00	.	518.00	10281.00
3	.	3287.00	19593.00	190994.00	.	.	189022.00	402896.00
4	.	247492.00	174749.00	93201.00	.	13028.00	15585.00	544055.00
5	22854.00	4741.00	132.00	0.00	71654.00	1662.00	29420.00	130463.00
6	152535.00	137551.00	66247.00	32883.00	317226.00	5693.00	75506.00	787641.00
7	44740.00	424825.00	11928.00	104543.00	1558.00	257074.00	223193.00	1067861.00
8	49381.00	83320.00	.	.	.	.	.	132701.00
9	11693.00	6616.00	.	.	64380.00	.	.	82689.00
10	4340.00	2591.00	.	.	60421.00	.	.	67352.00
11	30405.00	253251.00	17066.00	37352.00	56988.00	34324.00	118702.00	550088.00
12	6090.00	26850.00	187772.00	21598.00	40135.00	272.00	3602.00	286319.00
ALL	338166.00	1254202.00	515870.00	524775.00	693855.00	330341.00	707866.00	4366075.00

MAJOR SOIL GROUPS 1=RECENT SOILS, 2=RENDZINA SOILS,
3=YGE & INTERGRADES, 4=YBPU & VOLCANIC INTERGRADES,
5=YBSANDS & VOLCANIC INTERGRADES, 6=YBE - N & CENTRAL,
7=YBL & INTERGRADES, 8=BROWN GRANULAR LOAMS,
9=BROWN GRANULAR CLAYS & BRGRLOAMS & CLAYS, 10=BROWN & RED LOAMS
11=GLEYS & ORGANIC SOILS, 12=STEEPLAND SOILS

APPENDIX 57 AREA (HECTARES) IN PROVINCES OF LOW AND HIGH PRODUCING PASTURES OF NORTH ISLAND SOILS IN GRASSLAND, OF MAFES FARM CLASSES OF THE NORTH ISLAND

MAFESFC HARD HILL

	MAFESFC HARD HILL			MAFESFC EASIER HILL			MAFESFC INTENS.FIN		
	AREATYPE			AREATYPE			AREATYPE		
	HIGH PROD.	LOW PROD.	ALL	HIGH PROD.	LOW PROD.	ALL	HIGH PROD.	LOW PROD.	ALL
	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES	HECTARES
	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM	SUM
PROVINCE									
AU	7289.00	7600.00	14889.00	112572.00	6471.00	119043.00	218305.00	1226.00	219531.00
BP	35573.00	78331.00	113904.00	184772.00	257392.00	442164.00	1033857.00	107149.00	1141006.00
EC	15931.00	57694.00	73525.00	271116.00	129170.00	400286.00	229923.00	19892.00	249815.00
HB	4742.00	53324.00	58066.00	105994.00	235484.00	341478.00	414039.00	59846.00	473885.00
NO	10952.00	7791.00	18743.00	417018.00	37978.00	454996.00	265885.00	5643.00	271528.00
TA	6169.00	114055.00	120224.00	74500.00	68940.00	143440.00	249672.00	15808.00	265480.00
WE	28461.00	489943.00	518404.00	118699.00	358124.00	476823.00	560706.00	89464.00	650170.00
ALL	109017.00	808738.00	917755.00	1284671.00	1093559.00	2378230.00	2972387.00	299028.00	3271415.00

AU = AUCKLAND, BP = BAY OF PLENTY, EC = EAST COAST,
HB = HAWKES BAY, NO = NORTHLAND, TA = TARANAKI
WE = WELLINGTON